WATER & SEWAGE WORKS

WATER SUPPLY • INDUSTRIAL WASTE TREATMENT • SEWAGE DISPOSAL

MARCH
1951

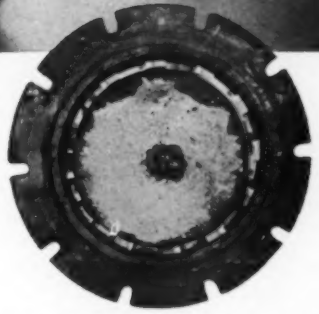
It's easy to tap!

LOCK JOINT
CONCRETE PRESSURE PIPE

Lock Joint Pressure Pipe of any design may be tapped easily and economically for the purpose of establishing either large connections or small service outlets. With the aid of a few simple instructions, any experienced service crew can apply the modern tapping technique which permits the making of connections in concrete pressure pipe while the line continues to operate under pressure.

Although, for many years, taps have been made successfully in concrete pressure pipe, today's efficient equipment and modern methods now make it possible to tap Lock Joint Concrete Pressure Pipe with even greater economy of time, money and effort, and without sacrificing strength.

At your request we would be glad to send you our booklet outlining the simple steps required in making a pressure tap in Lock Joint Concrete Pressure Pipe.



LARGE PHOTO: Tapping a 16" outlet in a 36" pipe at Wayne County, Michigan.

SMALL PHOTO: The pilot drill of the tapping machine withdraws the concrete core, making a clean cut, and leaving no obstruction within the pipe line.

Lock Joint Pipe Company for over forty years has specialized exclusively in the manufacture of reinforced concrete pipe for water supply and transmission mains as well as for sewers, culverts and subaqueous installations.

LOCK JOINT PIPE COMPANY

Est. 1905

P.O. Box 269, East Orange, N. J.

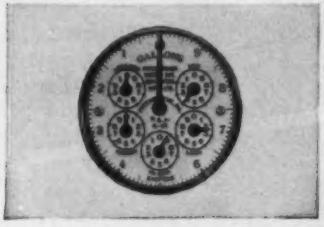
PRESSURE PIPE PLANTS: Wharton, N. J., Turner, Kan., Detroit, Mich.

BRANCH OFFICES: Casper, Wyo. • Cheyenne, Wyo. • Denver, Col. Kansas City, Mo. • Valley Park, Mo. • Chicago, Ill. • Rock Island, Ill. Wichita, Kan. • Kenilworth, N. J. • Hartford, Conn. • Tucumcari, N. Mex. Oklahoma City, Okla. • Tulsa, Okla.

WATER LEAKS DETECTED AT A GLANCE

Sweep Hand Registers Simplify Checking High Bill Complaints

Have you ever run across a hard-to-convince customer—one who insists his water bill is too high even after you have repaired or replaced his meter? Then stop, look and listen; there's an easy way to show him that his too-high bill is due to leaking fixtures. You can do it without any special recording devices or ex-



Circular type register with large center test hand

pensive attachments—if there's a Rockwell water meter already on the service line.

Slightest Movement Seen

You see, all Rockwell meters (Arctic, Tropic, Empire) are factory fitted with registers having large, red center test hands. Like the split second hand of a stop watch, this large hand sweeps the entire outer circumference of the dial. The slightest movement of this hand can readily be seen which is not the case of registers fitted with the conventional small test hand.

Watch The Red Test Hand

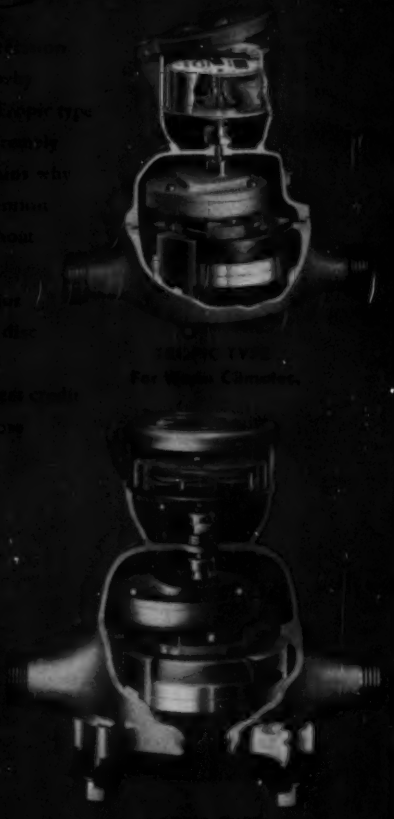
Hence all you need do to demonstrate leakage to your doubtful customer is to tour the premises with him and make sure all outlets are closed. Then let him watch the large red test hand. If it moves even slightly both you and your customer have proof positive that there is an unsuspected leak on the premises.

Another advantage of the large test hand is its use in checking new or repaired meters for accuracy. This hand permits easier reading and much closer reading than is the case with ordinary water meter registers.

Precision...

THE OUTSTANDING CHARACTERISTIC OF

ROCKWELL DISC METERS



Rockwell MANUFACTURING COMPANY

stock up on SANITATION HTH

Sanitation HTH is available in cases of nine handy 5-lb. cans or 100-lb. drums.

Not only severe conflagrations, but broken mains, floods and many other emergencies can overtax your chlorination system. For situations like these, it's wise to be prepared. And one of your most helpful assets is a good stock of Sanitation HTH. Its value as a versatile and reliable source of chlorine has been proved time and time again.

HTH is a 70% chlorine carrier – free-flowing, easy to use, handle and store. It will help you out during a major emergency as well as in such everyday jobs as sanitizing reservoirs, tanks, new mains and filters.

Check your supplies of Sanitation HTH today. Be sure to have sufficient stock on hand to keep pure water flowing to your users. For full information on the many practical uses of HTH, write for your copy of "Hypo-Chlorination of Water." Mathieson Chemical Corporation, Mathieson Building, Baltimore 3, Maryland.

Mathieson
CHEMICALS

8901

SERVING INDUSTRY, AGRICULTURE AND PUBLIC HEALTH

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WATER & SEWAGE WORKS

WATER SUPPLY • SEWAGE DISPOSAL
INDUSTRIAL WASTE TREATMENT

COMING ARTICLES

"WATER—MYSTERIOUS; COMMONPLACE; STRANGE; DESTROYING; VITAL," by W. B. Walraven constitutes excellent background material for public speaking and newspaper articles. "MINOR MAIN EXTENSIONS," from D. R. Taylor of Baton Rouge, offers a method of determining the proper and economical main size. "PRACTICAL ASPECTS OF SEWAGE CHLORINATION," by L. F. Warrick, is a companion article to E. W. Moore's "Fundamentals of Sewage Chlorination" in this issue. "WATER HAMMER CORRECTIVES," by Richard Bennett of Phoenix, Ariz., in a 1951 manual on methods and equipment for eliminating surge and water-hammer. "SEWAGE SAMPLING," by K. L. Mick and M. L. Robbins, constitutes an up-to-the-minute guide to reliable practices in sewage sampling.

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2 decades of CLEAN

22 Years of 'Round-the-Clock Operation Proves Dependability of G-E Equipment

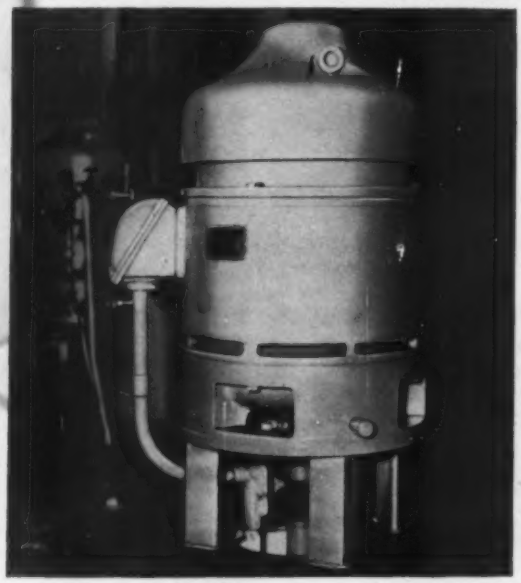
Backed by General Electric motors and control, the Greater Greenville Sewage Treatment and Disposal Plant has maintained Clean Waters for the people of Greenville, S.C. for the past 22 years.

The present installation includes some 57 G-E motors, 3 G-E generators, and a wide variety of G-E control equipment. According to the operating superintendent, General Electric equipment has never let them down during the 22 years of continuous operation—a good indication of the kind of service you can expect from G-E co-ordinated electrification.

In 1951, this far-sighted city expects to meet the new demands of its expanding population with a complete modernization and expansion of its pollution-control facilities.

General Electric can help you, your consulting or city engineer, and your contractor in (1) winning public support with the complete G-E packaged program "Modern Sewage Treatment" including the full-color sound movie Clean Waters, and (2) by assisting in the formulation of electrical plans.

Make your pollution-control program a success by contacting your G-E representative early in the planning stage. *Apparatus Dept., General Electric Co., Schenectady 5, N. Y.*

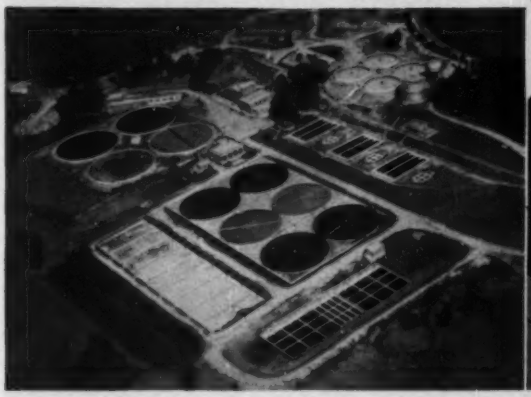


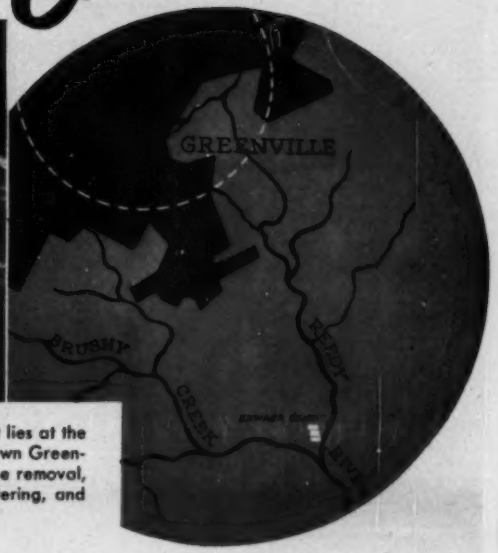
The present Greenville plant has 8 G-E motor-driven pumps. The above 20-hp vertical dripproof unit is coupled to a centrifugal pump for raw sewage. The cast-iron construction is highly resistant to corrosion.

Recirculation from filters to raw sewage is accomplished with G-E motor-driven pumps. Full-voltage starters are mounted in watertight enclosures (right).

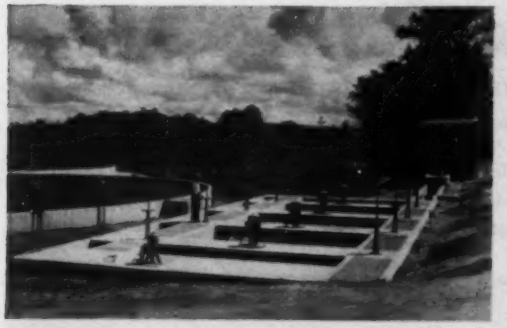
GENERAL ELECTRIC

WATERS *at Greenville*





The Greater Greenville Sewage Treatment and Disposal Plant lies at the junction of Brushy Creek and Reedy River, 5 miles from downtown Greenville, S. C. Treatment includes coarse screening, grit and grease removal, pumping, aeration, primary and final clarification, trickle filtering, and sludge digestion and drying.



Mechanical aerators at Greenville are driven by the sturdy General Electric vertical motors shown here. These outdoor installations have withstood the abuse of all extremes of weather.

G-E vertical motors and G-E control for sedimentation tanks are mounted on pipes above high-water level. Like other G-E equipment at Greenville, they have given years of dependable service.

GE SEWAGE-PLANT

How they made Philadelphia's 42" force main *Bottle-tight* though it lay 15' below the water table

The specifications for Philadelphia's 42" force main sewer were right to the point. "Zero infiltration", they read. What made it worse — the line lay 15' below the water table.

How can you couple 8' long sections of 42" bore concrete pipe and be sure they're *leakproof* — and will stay that way?

Wisely the engineers specified Tylox, the rubber joint that has earned the reputation of being "leakproof for the life of the line."

"Zero infiltration", the specs read. "Zero infiltration" they got. Tested under 15 psi internal hydrostatic pressure, *Philadelphia's force main was bottle tight.*

On that next tough sewer problem, take a tip from Philadelphia, or Oklahoma City, or Covington, Ky., or San Antonio, Texas, specify TYLOX *flexible rubber* JOINTS.

THUMBNAIL FACTS ABOUT PHILADELPHIA'S 42" FORCE MAIN

PIPE: "Vacuum processed" concrete pipe made only by the Concrete Products Company of America or its licensees. 42" bore, 8' lengths.

COUPLINGS: Tylox flexible rubber joints.

ENGINEERS: Bureau of Engineering & Surveys of the City of Philadelphia.

CONTRACTORS: Joseph Lombardi & Son, Philadelphia.

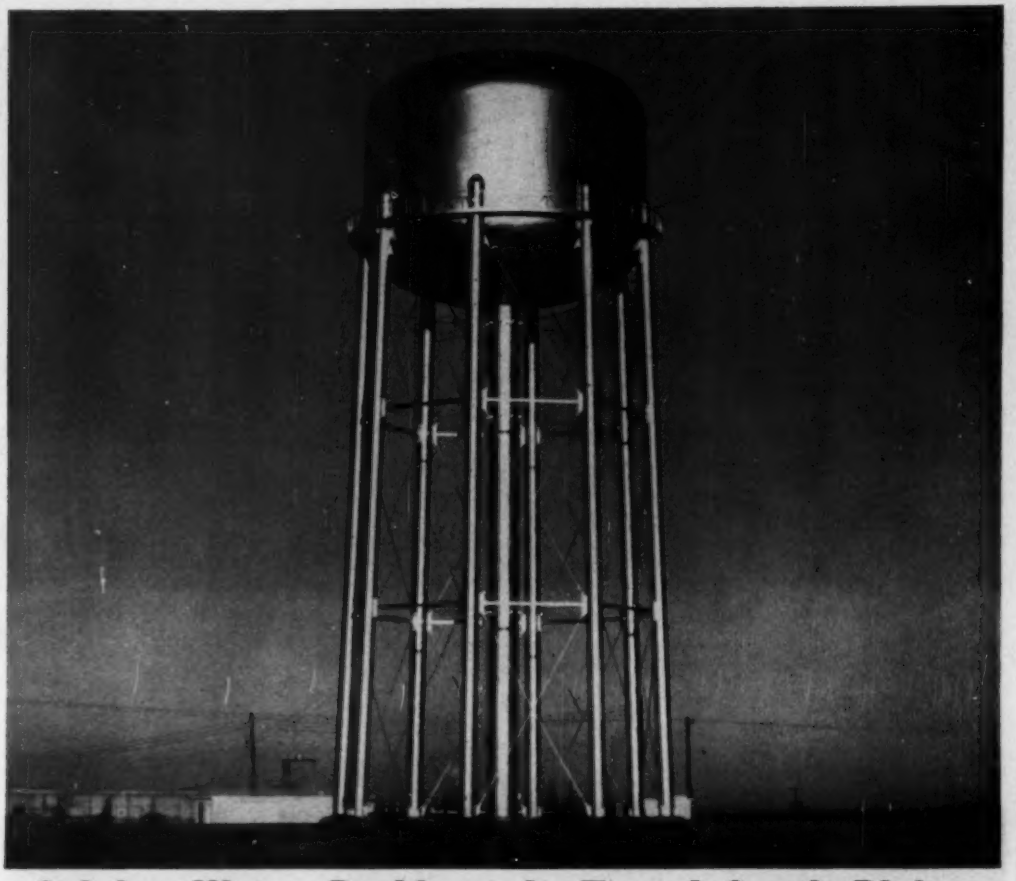
MAKING JOINTS WITH TYLOX RUBBER GASKETS IS AS SIMPLE AS ABC

Cement tongue and snap on Tylox gasket.

Lubricate sliding surfaces with Tylox Cement.

Shove the pipe home.

"THE ONLY PERMANENTLY TIGHT LINES ARE LAID WITH RUBBER JOINTS"



Solving Water Problems in Texas' South Plains

Good irrigation, good soil, and plenty of oil are transforming the once comparitively unproductive South Plains of Texas into an area of booming cities and prosperous farms.

Levelland, Texas, stands out among these communities both for its growth and its prosperity.

Where thirty years ago there were only 137 people in the whole county, there are now 11,000 in Levelland alone. And where there were once only scattered farms and ranches, there are now flowing oil wells and neatly plowed rows of King Cotton.

However, such a rapidly growing city is naturally faced with water problems . . . especially in the newer sections. Low pressures, pressure variations, and high pumping costs are most common.

Recently, Levelland installed a Horton elevated water tank to alleviate these problems. This 400,000 gallon structure helps supply clear well water to 2300 customers. And equally important is the fact that it is a dependable water supply . . . because it's backed by gravity pressure.

Elevated water storage facilities like this are used by countless cities throughout the country. They've discovered those special features—high pressure, reduced pressure variations and decreased pumping costs—that mean more efficiency.

Horton elevated tanks for municipal service are available in standard capacities ranging from 5,000 to 3,000,000 gals. For complete information, write our nearest office.

HORTON

WELDED STEEL

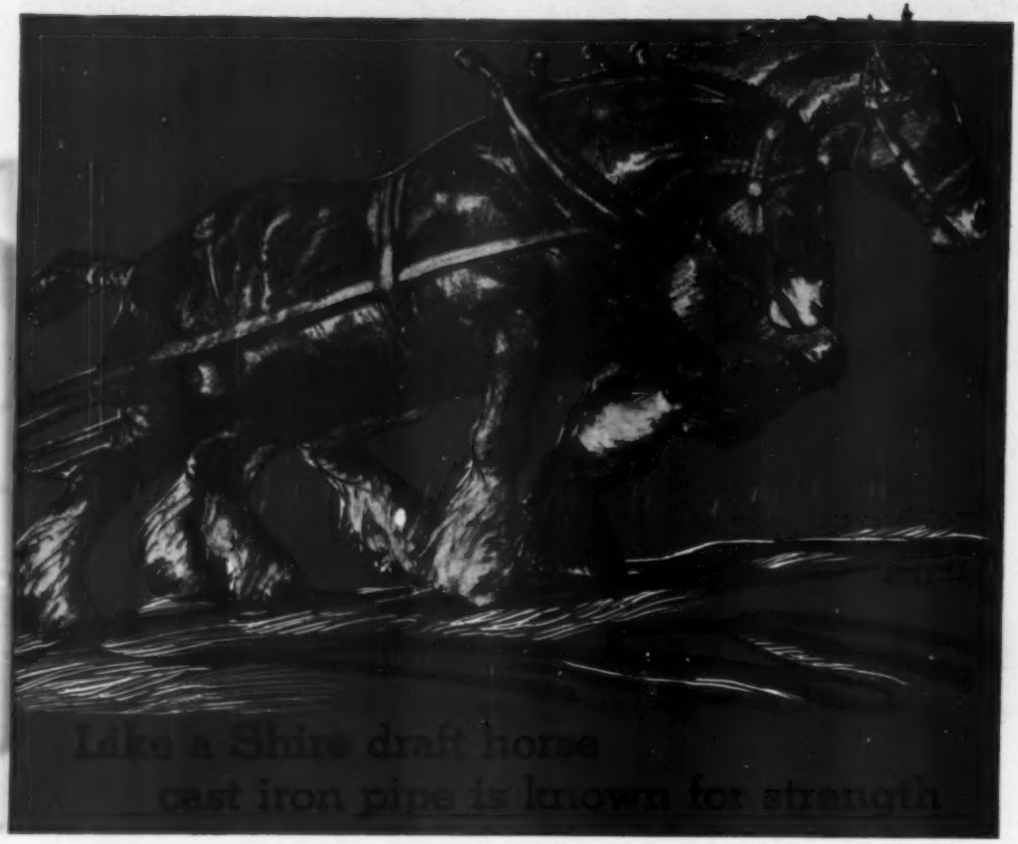
STORAGE TANKS

CHICAGO BRIDGE & IRON COMPANY

Plants in Birmingham, Chicago, Salt Lake City, and Greenville, Pa.

Atlanta 3	2181 Healey Building	Los Angeles 14	1565 General Petroleum Building
Birmingham 1	1886 North Fiftieth Street	New York 6	3390-165 Broadway Building
Boston 10	1048-201 Devonshire Street	Philadelphia 3	1644-1700 Walnut Street Building
Chicago 4	2198 McCormick Building	Salt Lake City 4	850 West 17th South Street
Cleveland 15	2262 Guildhall Building	San Francisco 11	1583-200 Bush Street
Detroit 26	1551 Lafayette Building	Seattle 1	1350 Henry Building
Houston 2	2115 National Standard Building	Tulsa 3	1646 Hunt Building
Havana	402 Abreu Building	Washington, D.C	Cafritz Building

The STRENGTHS you need



The strengths demanded of pipe to be laid under expensive modern pavements, if costly repairs and replacements are to be avoided, are known strengths—proved by experience and determinable by tests. The four strength factors that pipe must have to withstand beam stresses, external loads, traffic shocks and abnormal working pressures are listed on the opposite page. *No pipe, deficient in any of these strength factors, should ever be laid in paved streets of cities, towns or villages!* Cast iron water and gas mains, laid over a century ago, are serving today in the streets of 30 or more cities. These service records prove that cast iron pipe not only resists corrosion but has all the vital strength factors of long life and economy.

CAST IRON PIPE

in pipe for city streets . . .

No pipe that is deficient in any of the following strength factors should ever be laid under paved streets.

CRUSHING STRENGTH

The ability of cast iron pipe to withstand external loads imposed by heavy fill and unusual traffic loads is proved by the Ring Compression Test. Standard 6-inch cast iron pipe withstands a crushing weight of more than 14,000 lbs. per foot.

BEAM STRENGTH

When cast iron pipe is subjected to beam stress caused by soil settlement, or disturbance of soil by other utilities, or resting on an obstruction, tests prove that standard 6-inch cast iron pipe in 10-foot span sustains a load of 15,000 lbs.

SHOCK STRENGTH

The toughness of cast iron pipe which enables it to withstand impact and traffic shocks, as well as the hazards in handling, is demonstrated by the Impact Test. While under hydrostatic pressure and the heavy blows from a 50 pound hammer, standard 6-inch cast iron pipe does not crack until the hammer is dropped 6 times *on the same spot* from progressively increased heights of 6 inches.

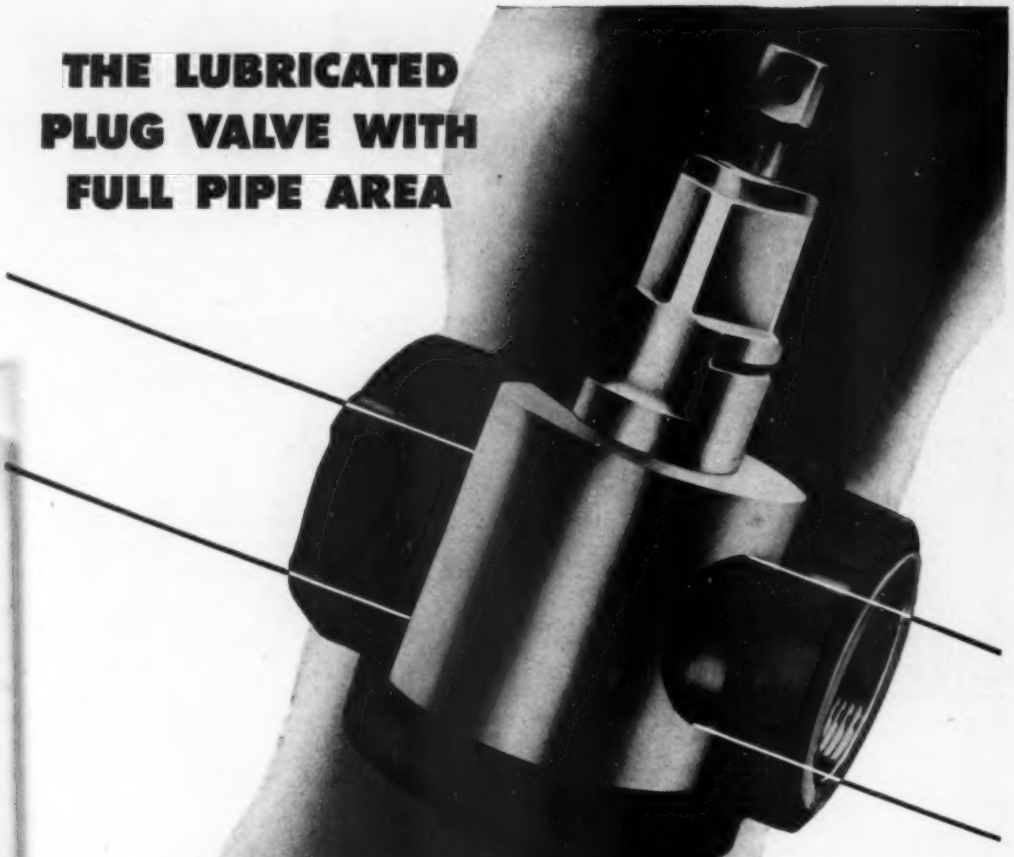
BURSTING STRENGTH

In full length bursting tests standard 6-inch cast iron pipe withstands more than 2500 lbs. per square inch internal hydrostatic pressure, which proves ample ability to resist water-hammer or unusual working pressures.

CAST IRON PIPE RESEARCH ASSOCIATION, THOS. F. WOLFE, MANAGING DIRECTOR, 122 SO. MICHIGAN AVE., CHICAGO 3.

SERVES FOR CENTURIES

THE LUBRICATED PLUG VALVE WITH FULL PIPE AREA



a.c.f. CYLINDRICAL PLUG VALVE DESIGN

makes it possible. Straight-through openings result in smooth, non-turbulent flow, lowest head loss, reduced valve abrasion. Yet compact valve construction is retained in both rectangular and round-port types. Reason enough for a.c.f. Lubricated Plug Valve preference.

a.c.f. CYLINDRICAL FULL PIPE AREA LUBRICATED **PLUG VALVES**

Representatives in more than 50 principal cities

Write for Catalog 4WS, describing types and sizes, to: American Car and Foundry Company, Valve Division, 1501 E. Ferry Ave., Detroit 11, Mich.

An Important Message for Everyone Who Buys Sewage Treatment Equipment

From Single Items To Complete Sewage Treatment Plants INFILCO Equipment Can Fill ALL Your Needs

Thinking about replacing old equipment or modernizing and increasing the capacity of a sewage treating plant? INFILCO can provide a complete range of equipment and control devices from which to choose.

Planning an entirely new plant? INFILCO offers you the advantage of a *one-source* supply for *all* your needs. Whether your plans call for chemical or biological treatment, you can depend upon INFILCO for the most modern equipment available.. equipment that will be modern *for years to come!*

A complete laboratory and staff of competent engineers are available for making recommendations and reports.

When considering your next sewage treatment plant or the modernization of an existing plant—consider the advantages of Infilco Service and Equipment. The Infilco Field Engineer is only a telephone call away. Consult your Classified Directory or write our executive offices in Tucson.

SEND FOR *8-page Bulletin No. 60-C. It contains illustrated descriptions covering the many superior advantages of Infilco Sewage Treatment Equipment.*

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- *Digesters*
- *Gridvector®*
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Quality Engineered for Quality Performance

INFILCO

BETTER WATER CONDITIONING AND WASTE TREATMENT SINCE 1894

INFILCO INC.

NEW YORK 17 • **TUCSON** • CHICAGO 16

SALES OFFICES IN TWENTY SIX PRINCIPAL CITIES

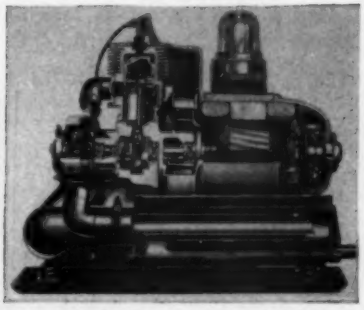
WORLD'S LEADING MANUFACTURERS OF WATER CONDITIONING AND WASTE TREATING EQUIPMENT

You Need All Three...You Get All Three

1. PERFORMANCE, 2. DEPENDABILITY, 3. SERVICE

HOMELITE *Carryable* GENERATOR

1. Performance. True, a Homelite Gasoline-Engine-Driven Generator is light enough for one man to pick up and carry but its performance is big enough to operate any electric tools or brilliant floodlights for night work. In fact, it gives you power *plus* . . . power plus a large overload capacity . . . power that isn't sapped by long dangerous cables. Easy to get on the job; quick to start at all times, never bothered by extreme temperatures, a Homelite is always ready with electric power in any emergency. It will save time and money for you on all jobs. Ask for a free demonstration and see for yourself.



2. Dependability. For more than 25 years, Homelite engineers have specialized in building carryable gasoline-engine-driven units. Their experience in building close to three hundred thousand of these units has been responsible for the simplicity of design and precision construction with finest materials that insure long-haul dependability and lowest maintenance costs.

3. Service. A Homelite seldom needs service, but when it does, there's a trained Homelite service man near you . . . a man who will drive his truck right out to your job and put your Homelite in perfect operating condition. This prompt, competent service is a great money saving factor for those who want to get continuous production out of their power tools.

STICK TO THE RULE OF THREE 1. Performance 2. Dependability 3. Service, and you'll always stick to a Homelite

DEPENDABILITY
PERFORMANCE
SERVICE

HOMELITE
CORPORATION

703 RIVERDALE AVENUE, PORT CHESTER, NEW YORK

MANUFACTURERS OF HOMELITE CARRYABLE PUMPS • GENERATORS • BLOWERS • CHAIN SAWS •

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in BETTER WATER STORAGE

Elevated Steel Tanks

by

PITTSBURGH • DES MOINES

Dependable water service for the progressive community is marked with distinction by P-DM Elevated Steel Tanks. Handsome in appearance, efficient in performance, economical to use and maintain, Pittsburgh-Des Moines Tanks are always a sound investment. *Write for our latest Water Storage Brochure.*

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When you join pipe with Dressers, you make joints fast—two man-minutes per bolt or faster. And when they're made, they're tight . . . *flexible-tight.*

Dressers provide the give-and-take that accommodates pipe laying variations. Their resilient gaskets absorb stresses and strains, expansion and contraction movement.

No delays—most waterworks operators backfill a Dresser line right on the heels of the laying crew, secure in the knowledge that steel pipe and Dresser Couplings give them complete dependability and positive joint tightness. You get more pipe into the ground per day and save expensive man-hours.

DRESSER

"FLEXIBLE-TIGHT"

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For latest data and follow-through service, see your Dresser Sales Engineer or write to our main office.

Information Courtesy Dept. of Public Works, New York City

Photo by Fairchild Aerial Surveys, Inc.

The vital importance of air diffusion processes to New York City's extensive pollution control program was at once evident to its engineers. Five large plants now use activated sludge or modified aeration treatment, three more are under construction, and several others are planned.

This type of aeration gives the high degree of treatment—at low cost—needed to meet New York City's acute conditions. Dense population, limited plant sites, and odor control are all critical factors.

Porous ceramic diffuser plates and tubes *have been used exclusively* for this program. *And* ALOXITE *aluminum oxide diffusers are installed in four of the five aeration plants now operating—and will be installed in all three under construction.*

These are the 8 sewage treatment plants
Wards Island
Tallmans Island
Bowery Bay
Jamaica
26th Ward
Hunts Point
Owls Head
Rockaway

May we send you our new booklet, "Porous Media for Filtration and Diffusion"? Its 56 pages are crammed with useful data. No obligation, of course.

THE CARBORUNDUM COMPANY
Dept. M-31, Refractories Div. • Perth Amboy, New Jersey

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piping repairs *cost more* now!

No. 488 Iron Body Clamp Gate

You make them less often by using Dependable Quality

CRANE VALVES

...That's why more Crane Valves are used than any other make

easy access prevents trouble with this valve

Remove just two nuts to dismantle this gate valve for inspection, cleaning, or repairs—without taking it from the line. Reassemble just as easily, knowing that Crane clamp design keeps the bonnet joint snug and accurately aligned. Use Crane Clamp Gates on steam, water, and air, but especially in heavy fluid lines needing periodic cleanout. They'll save time, labor, and encourage regular servicing that prevents valve trouble.

Combining easy access with highly dependable service features, Crane Clamp Gates typify Crane Quality—*better valve performance at lowest ultimate cost.*

CRANE

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Branches and Wholesalers Serving All Industrial Areas

VALVES • FITTINGS • PIPE • PLUMBING • HEATING

THE SPIRAL CONVEYOR

Jeffrey Spiral Conveyor handling alum and lime in a large Water Works Plant. A section of Spiral flight is also shown.

A COMPACT INSTALLATION

Used extensively in Water Works Plants for handling lime, alum or other chemicals—saving time and cost. Jeffrey Spirals make compact installations—can be made dust-tight. No return strand. Capacities vary with size of unit.

Photo above shows a Jeffrey Spiral installation in a large Ohio Water Works Plant. Note the clamped cover used when handling dusty material—also the various rack and pinion valves in the trough bottom for delivery of material when and where needed.

Catalog No. 803-A fully describes and pictures Jeffrey Spirals. Catalog No. 775-A covers our complete line of Sewage, Water and Industrial Waste Treatment equipment.

- Sludge Collectors
- Sludge Elevators
- Grit Washers & Collectors
- Flocculation Equipment
- Bar Screens
- Spiral Conveyors
- Chains—Bearings
- Grinders

THE JEFFREY MANUFACTURING COMPANY

Established 1877

996 North Fourth St., Columbus 16, Ohio

Complete Line of Material Handling, Processing and Mining Equipment

Baltimore 2 Boston 16 Cincinnati 2 Detroit 13 Jacksonville 2 Philadelphia 3 Salt Lake City 1
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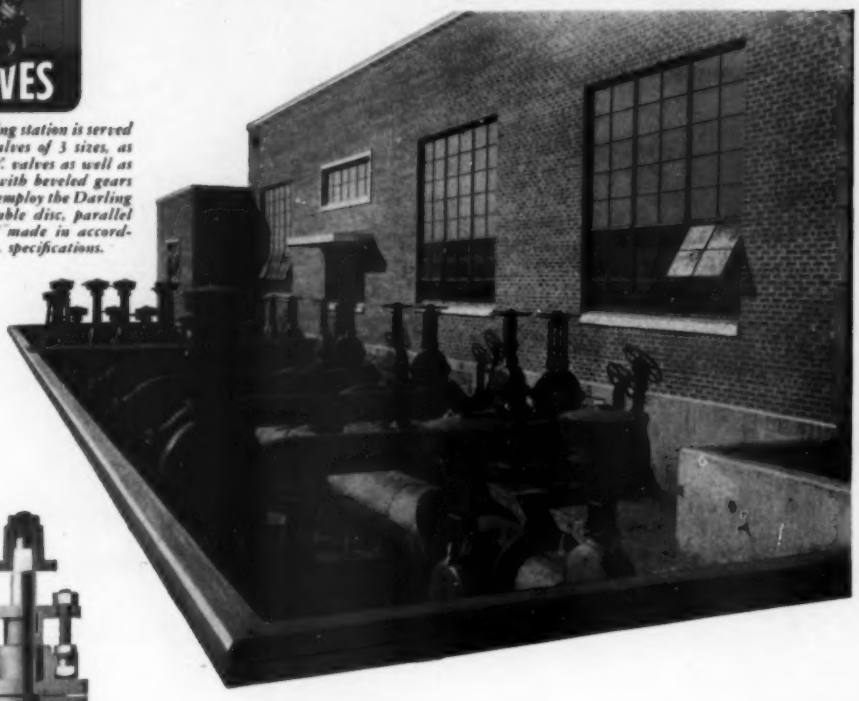
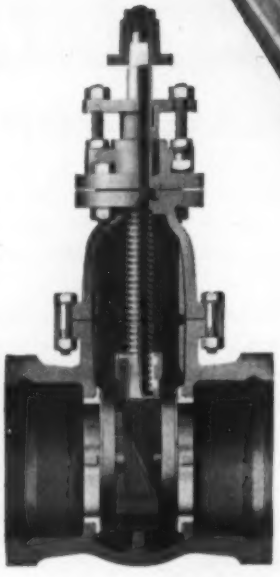
DARLING VALVES

FOR PLUS VALUES, JOB-PROVED AGAIN AND AGAIN

This modern pumping station is served by Darling gate valves of 3 sizes, as shown—20" O.S.&Y. valves as well as 30" and 36" sizes with beveled gears and gear cases. All *employ the Darling fully revolving, double disc, parallel seat principle, and made in accordance with A.W.W.A. specifications.*





Note rugged simplicity of this unique Darling principle—just four sturdy working parts . . . two plain interchangeable no-pocket discs and two husky wedges. Assembly and maintenance is extremely easy and foolproof.

Time and money ahead

THIS new municipal pumping station gains a unique advantage proved in hundreds of similar operations throughout the country. Because these gate valves are Darlings . . . *featuring Darling's fully revolving, double disc, parallel seat principle* . . . the city as well as the water department will be time and money ahead years on end.

If you haven't yet checked into Darling gate valves of this type (shown in cutaway view at left) we'd like to give you *all* the facts on the distinctive features that always add up to . . .

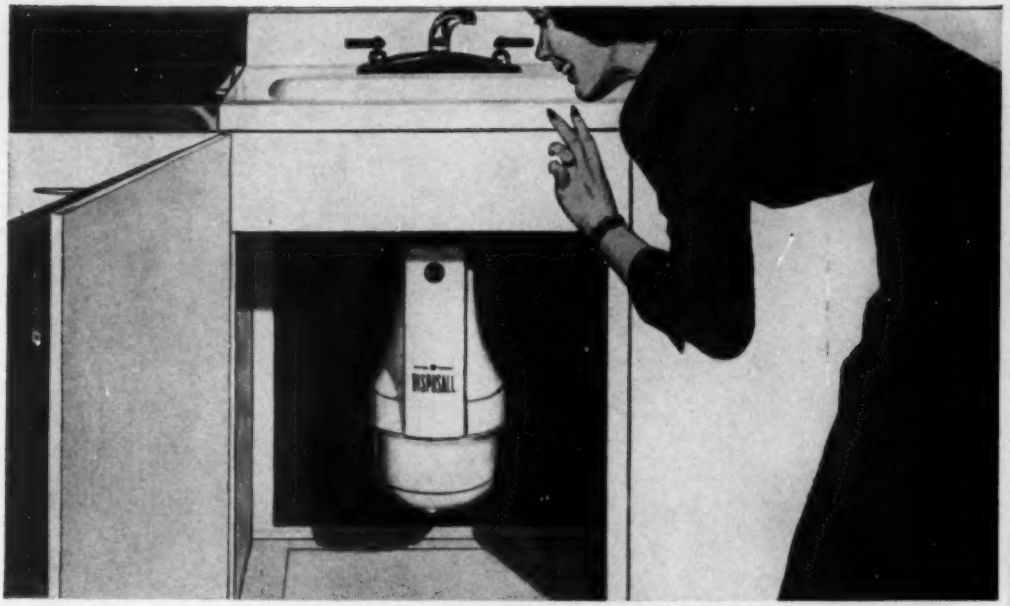
1. Positive, easier closing. 2. Automatic adjustment for valve body distortion. 3. Elimination of disc-to-seat galling. 4. Uniform wear distribution. 5. Greater service life with far less maintenance.

SEND FOR BULLETIN

Darling's latest bulletin is full of helpful information and describes Darling valves of *all* types for every normal or unusual service.

DARLING VALVE & MANUFACTURING CO.

Williamsport 11, Pa.



Opening the door for a friend of the community!

Meet the latest, greatest friend of housewives —of sanitary officials—of communities everywhere.

Meet the sure, powerful enemy of garbage —of the filth and disease that garbage breeds.

Greet the new, compact, efficient General Electric Disposall®—designed to fit practically every sink . . . built for years and years of dependable operation!

There's everything new and better about this food-waste shredder—from the all-white, kitchen-bright exterior—to the smallest working part. The shredder and rotating impellers, made of one of the toughest alloys known, will really grind food waste—from rubbery fruit skins to the most stubborn beef bones.

G-E engineers have added safety factors—including the strength to prevent mechanical breakdown if foreign objects of glass or metal should be dropped in accidentally with food wastes.

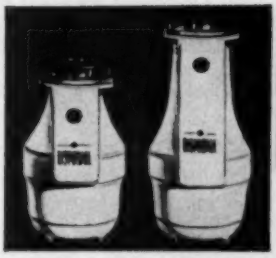
There's built-in economy, too! For, on a yearly average, this G-E Disposall will use less electricity than an electric clock—will use less water than is now required to clean sinks, sink strainers and to flush out garbage containers. And, because it is built and designed for a long life with little or no maintenance, the actual owning cost of a Disposall has been found to average as little as 10¢ per unit per year.

First, last and always, though, the Disposall means SANITARY PROTECTION. It shreds food wastes to small, uniformly sized particles and discharges them at an even rate—in the combination found best through 15 years of G-E experimentation. And these particles are washed away in water with a scouring action that keeps traps and pipes whistle-clean.

Whether wastes are disposed of through sewer or septic tank, the G-E Disposall preserves the full benefits of the sanitary plumbing system—all the way from sink to sewage treatment plant!

Truly, there is no food-waste shredder that can match the new G-E Disposall in design, in performance, in dependability.

As guardian of the community, of its health, safety and economy, you will surely want to open the door for a great friend of the community—the new G-E Disposall!

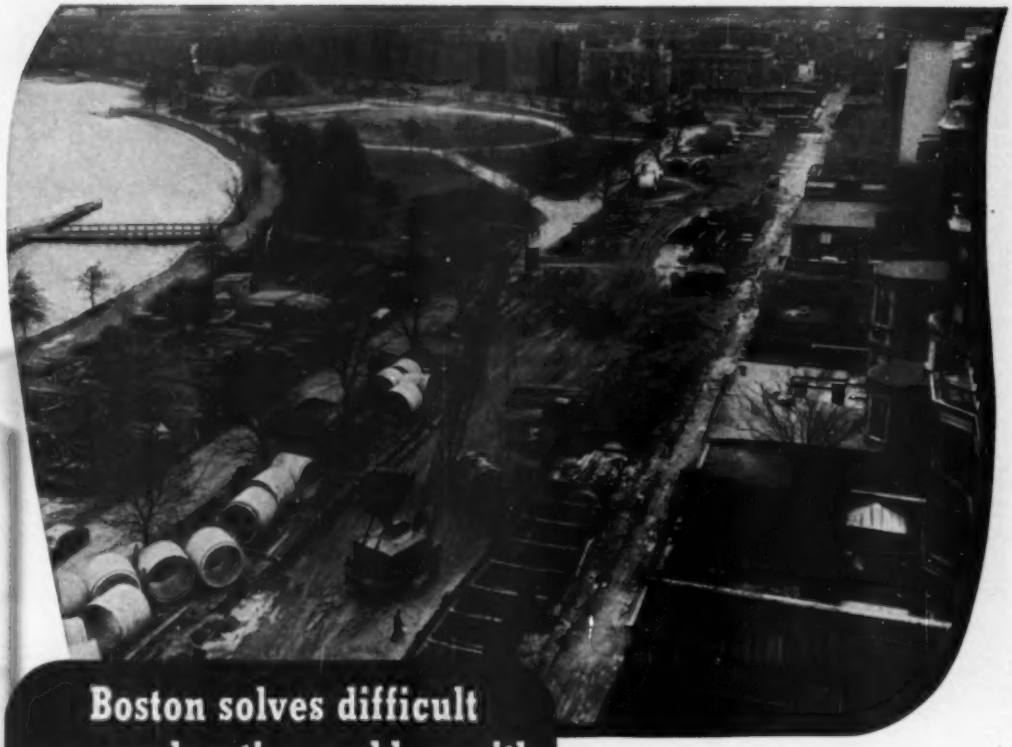


New, streamlined G-E Disposall is available in two models. Quick, easy installation can be made in practically every sink. For further information about the Disposall method, simply write to Department WSW 351, General Electric Co., Bridgeport 2, Conn.

G-E DISPOSALL

You can put your confidence in—

GENERAL ELECTRIC



Boston solves difficult sewer relocation problem with CONCRETE PIPE

To make way for a vehicular tunnel on the new four-lane James J. Storrow Memorial Embankment Expressway along the Charles River in the Back Bay section of Boston it was necessary to relocate an 8-ft. diameter marginal conduit.

Because of its many qualities, reinforced concrete pipe was chosen for the new sewer. In all, 2040 ft. of 96-in. straight pipe and 225 ft. of 96-in. radius pipe was used, manufactured in 8-ft. lengths (ASTM specification C76-41, Table 1).

The subsoil in the area was so soft it was deemed necessary by the Metropolitan District Commission engineers to build a special support for the pipe by driving piles into the subsoil and adding a bed of gravel covered with a concrete mat. This uniform support at the base of the pipe increased the load the pipe can carry.

This is another example of how concrete pipe can be used to solve difficult or unusual sewer problems. In thousands of installations over scores of years concrete pipe has demonstrated its rugged durability, great structural strength, maximum hydraulic capacity, minimum infiltration and leakage, resistance to wear by abrasive matter.

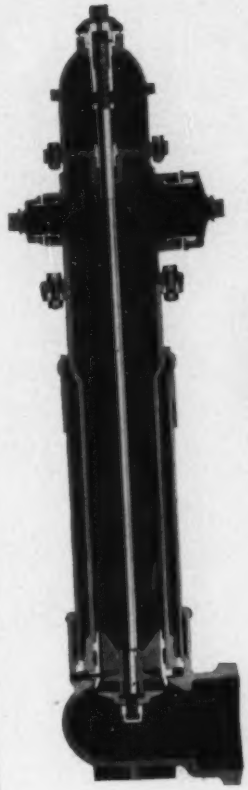
Concrete pipe is moderate in first cost, requires little or no maintenance and serves longer. The result is real *low-annual-cost* sewer service.

●

Photo at right shows 8-ft. concrete pipe being lowered and placed in open cut. Note use of sheeting on walls of trench to prevent cave-in of the soft subsoil.

AMERICAN CONCRETE PIPE ASSOCIATION

228 NORTH LA SALLE STREET, CHICAGO 1, ILLINOIS



Simplicity of design

The minimum of moving parts with rugged construction gives you a dependable hydrant with the minimum of maintenance. For instance, the drain valve, an integral part of the valve stem, is automatic and requires no adjustments.

MATHEWS
HYDRANTS

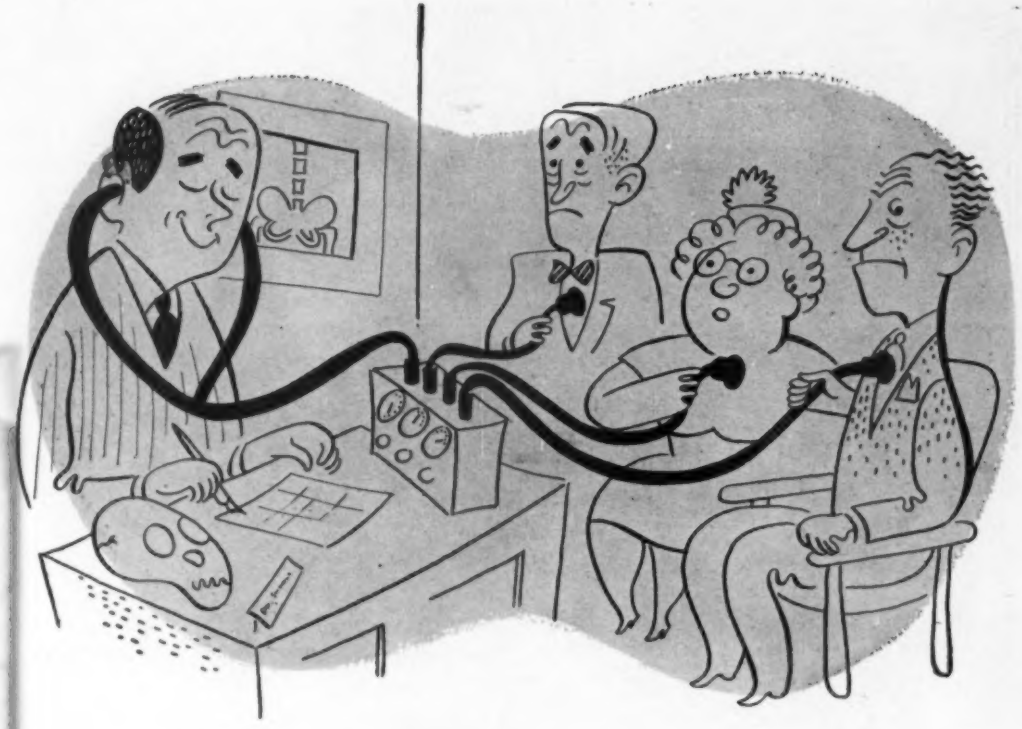
Made by R. D. Wood Company

Public Ledger Building, Independence Square
Philadelphia 5, Pa.

Manufacturers of "Sand-Spun" Pipe
(centrifugally cast in sand molds)
and R. D. Wood Gate Valves

Mathews Modernized Hydrants offer these advantages

Operating thread only part needing lubrication • Stuffing box cast integral with nozzle section—positively leakproof • Head turns 360° • Replaceable head • Nozzle sections easily changed • Nozzle levels raised or lowered without excavating • Protection case of "Sand-Spun" cast iron for extra strength, toughness, elasticity • A modern barrel makes an old Mathews good as new • Available with mechanical joint pipe connections



Reduced Treatment Costs

Less load at the disposal plant—and, therefore, a reduction in sewage treatment costs—is one of the practical advantages that often result from the use of Transite* Sewer Pipe.

There are two good reasons for this:

(1) Transite's special sleeve-type joints that cut sewer line infiltration to a minimum.

(2) Transite's long 13-foot lengths that reduce the number of joints in the line—an additional safeguard against infiltration.

Besides the immediate saving in treatment costs, this reduction in load also enables plant capacity to be conserved for future needs. And, where new treatment facilities are planned, it permits consideration of a smaller plant . . . with possible important economies in disposal equipment.

Other Transite Economies . . . Transite has an exceptionally smooth interior that reduces resistance to flow. This, combined with its long lengths that help maintain uniform grades, plus fewer joints that reduce turbulence, often permits designing the system with flatter grades and shallower trenches. Or, as an alternate economy, pipe of smaller diameter may be specified.

Transite Sewer Pipe is made of asbestos, cement and silica by a special method of manufacture which develops high, uniform strength and resistance to corrosion. It is available in four strength classes in sizes to 36". This permits selection of the pipe best suited to trench conditions, frequently eliminates the need for concrete cradles.

For further details, write Johns-Manville, Box 290, New York 16, N. Y.

JM

*Transite is a Johns-Manville registered trade mark

.....Johns-Manville

TRANSITE SEWER PIPE...

SIMPLICITY of AMERICAN FROST BOTTOM METERS

REDUCES YOUR REPAIR COSTS

There's no worry about freeze-ups of American Meters causing high repair bills. The simple patented frost bottoms break at the correct pressure to protect all other parts, because they are not affected by the tightening of the flange bolts.

Even replacement frost bottoms give the same protection because the breaking pressure is pre-tested at the factory and predetermined by the machining which produces the correct tensile strength.

Complete data available — write today.

BUFFALO METER CO.

2909 MAIN STREET, BUFFALO 14, NEW YORK

TOMORROW'S PIPE TODAY!

THE YEARS AHEAD will testify that CARLON is the finest and most durable pipe you can install. It is guaranteed against rot, rust and electrolytic corrosion and will far outlast ordinary pipe. Its resistance to sulphurous waters, alkalies, metallic salts and other corrosive wastes assures long range economy in the transmission of many fluids, gases and vapors. It is being used today for handling drinking water and sewage as well as for air intake and exhaust lines.

FLEXIBLE and RIGID types of CARLON are available in standard sizes to meet all working demands. In flexible form, it will conform to irregular ditch lines or structural plans so that few fittings are required. Rigid CARLON pipe makes-up fast with either threaded plastic fittings or cemented joints. Rigid CARLON can be threaded with standard pipe tools.

LIGHTWEIGHT CARLON plastic pipe can be handled and installed quickly and economically. No special tools are required, and pipe can be moved in great quantities without the need for heavy materials handling equipment.

You pipe for the future when you install CARLON PLASTIC PIPE.

For complete information, write to the CARLON PRODUCTS CORPORATION or see your nearest field representative.

CARLON CP

CARLON PRODUCTS CORPORATION

IN CANADA: MICRO PLASTICS, LTD., ACTON, ONT.

10132 MEECH AVE. • CLEVELAND 5, OHIO

LOOK TO WALKER PROCESS...

For the solution to your Water Works Problems

CAMP POROUS BOTTOMS
Bulletin 12S12
Water filter underdrain plates of crystalline fused alumina thoroughly bonded and kiln burned at a high temperature. Used in new and rehabilitated filters. Eliminates gravel and saves head room. Can be rehabilitated at will by acid treatment.

Fe-FLOCCULATING FILTER
Bulletin 1S44
Iron, manganese and gas removal by a simple backwashable two-stage contact filter. Combined iron and manganese removed to 0.2 ppm or less by one pass of the water through the contact media. Removal effected by autocatalysis of previous freshly formed precipitates. Second stage polishes effluent.

FOR WATER SOFTENING . . . TURBIDITY AND COLOR REMOVAL
. . . INDUSTRIAL WASTE TREATMENT . . .

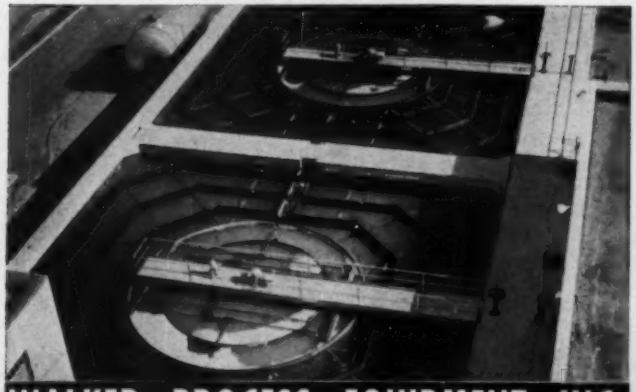
The Clariflow

with independently-operated mixing, flocculation, stilling and sedimentation zones

A notable improvement over conventional short-retention water treatment units. Provides individual functioning of mixing, flocculation, stilling and sedimentation zones. • Its control over short-circuiting, control over each function and control of sedimentation through low weir rates mean improved effluent . . . higher filtration rates . . . longer filter runs . . . better industrial waste recovery and treatment.

Write for Bulletin 6S6

Orlando, Florida Installation



WALKER PROCESS EQUIPMENT INC.
FACTORY • ENGINEERING OFFICES • LABORATORIES
518 HANKES AVENUE, AURORA, ILLINOIS
PROQUIP

CIRCULAR COLLECTOR
Bulletin 9S45
For all sizes of circular or square tanks. Collectors offered in three styles: The Tractor Drive on periphery of tank, Suspended mechanism driven from a drive on tank bridge, and Center Drive supported from a center pier. Influent may be either siphon-feed or cross-pipe feed.

RECTANGULAR COLLECTOR
Bulletin 8S34
Chain type collectors for all sizes of rectangular tanks. Featured with these collectors are the exceptionally strong torque tube drive shafts. Helicoid or rectangular cross collectors may be used with these collectors.

FS FLOCCULATION
Bulletin 3S3
Mechanical flocculation employing staged zonal recirculation. A series of interlaced rolling actions are imparted to the water within the tank. Each floc particle is slowly and repeatedly brought into contact with the suspensoids, which are absorbed as the floc develops.

CARBALL UNIT FOR CARBONATION
Bulletin 7S42
Highly efficient water cooled type carbon dioxide producers. Carbon dioxide diffusers of the impingement type with 93% efficiency in gas absorption.

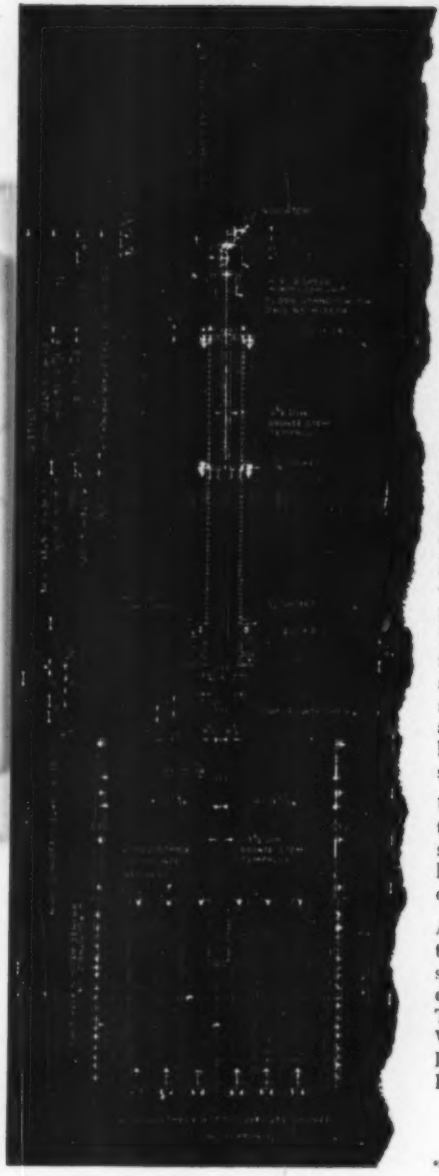
ENERGY MIX
Bulletin 2EM
Instantaneous blending of chemicals by the energy of incoming water. This unit should be considered with all coagulation problems.

RAPID MIXERS
Rapid Mix units are offered for any mixing problem. A complete line of suspended, pivoted and staged mixers is available.

DIFFUSAIR IMPINGEMENT AERATOR
Bulletin 17S31 and 37
A highly perfected and efficient aeration device for aerating liquids or inducing gas absorption. CO_2 is absorbed into liquids by higher absorption efficiencies than any other known aeration device.

Designs from engineers' notebooks

Sluice Gate in EVERDUR



Designed and built by the Coldwell-Wilcox Division of Krajewski-Pesant Manufacturing Corporation, this inlet and control gate shows an economical use of special metals to give long life.

EVERDUR* (copper-silicon alloy) facing strips, bolting and engaging surfaces were chosen as the best metal known to resist corrosion by tidal waters, partly salt and contaminated by effluents from industrial plants, sewage and the like.

The high-strength back pressure brackets are made of ANACONDA Manganese-Bronze, the same metal being used to couple the stem sections. The 4¼ in. diameter stem itself is of TEMPALOY*, an ANACONDA aluminum bronze having unusually high strength properties.

Use of these materials assures the freedom from rust and scaling essential to the long-lasting adequate strength and easy operation so much desired.

Anaconda engineers are available to cooperate with you to obtain similarly dependable and economical equipment. Write to: The American Brass Company, Waterbury 20, Connecticut. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

B1138

*Reg. U. S. Pat. Off.

Where corrosion resistance counts—consider **ANACONDA® COPPER ALLOYS**

. . . for proof of better pumping performance!

It's been said that split-case centrifugal pumps look pretty much alike. But looking alike does not mean "like" performance!

We've lifted the casing of a Fairbanks-Morse Single-Stage Split-Case Centrifugal to show you why you get *better* performance . . . *lower* maintenance costs with Fairbanks-Morse . . . to show you important design and manufacturing differences.

Note the sturdy construction and exceptional strength provided by the arched casing and solid pump base . . . the ease with which the entire pump can be inspected or the entire rotating element removed without disturbing driver or pipe connections. Exceptionally smooth water passages reduce friction and "back eddies" to the minimum. Bearing brackets, cast integrally with pump body, maintain accurate, permanent alignment of shaft and impeller. Smooth, one-piece impeller reduces wear and maintains efficiency. Impeller is pressed on shaft over a key so that the key also drives the shaft sleeves and prevents destructive rotation of the sleeve on the shaft. Removable casing and impeller wearing rings assure easy maintenance and have streamlined water guiding surfaces for maximum pump efficiency.

These are but a few of the many performance-making features you'll find in Fairbanks-Morse Centrifugals. Your Fairbanks-Morse Pump expert will be happy to give you the complete story on these efficient, economical pumps. See him or write Fairbanks, Morse & Co., Chicago 5, Illinois.

FAIRBANKS-MORSE,

a name worth remembering

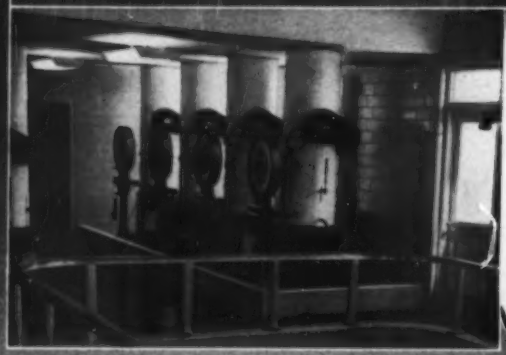
PUMPS • SCALES • ELECTRIC MOTORS
GENERATORS • LIGHT PLANTS • DIESEL,
DUAL FUEL AND GASOLINE ENGINES

STILLWATER, OKLA.

Oklahoma A & M College
Water Filtration Plant
(COMPLETED IN 1950)

Cochrane, Hendrix, Fell & Wheeler
W. R. Holway & Associates
Consulting Engineers
Tulsa, Oklahoma

Carrothers Construction Co.
Contractors
Paola, Kansas



BIF Industries equipment furnished for the Oklahoma A & M College Water Filtration Plant:

No. 2 Universal Feeders with accessories for feeding alum, hydrated lime and activated carbon.

10" Loss of Head and Rate of Flow Controllers with Gauges for filter effluent.

16" Venturi Tube with electrically operated Totalizer-Indicator-Recorder for Finished Water.

20" Propelaflo Meter for raw water to settling basin.

14" Propelaflo Meter for raw water to auxiliary basin.

This new Water Filtration Plant serves a double purpose at Oklahoma Agricultural & Mechanical College. It protects the health of the student body by furnishing a water supply of high purity, and it also serves as a practical operating laboratory for teaching sanitary engineering. Financed by the State of Oklahoma, the plant has a maximum capacity of 6 MGD, more than adequate for the demands of huge student enrollment and of the City of Stillwater, which it also supplies.

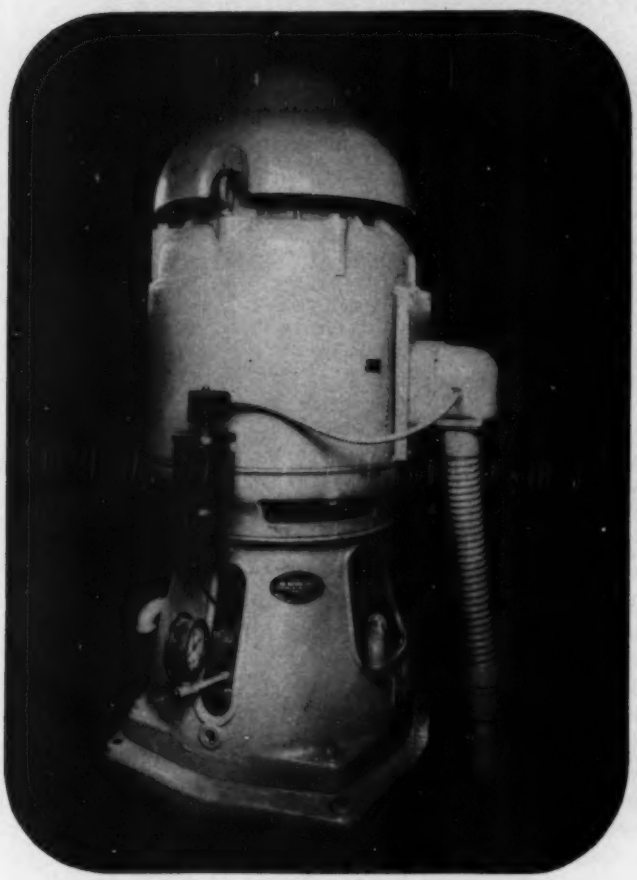
An important part of the water treatment process is the chemical feeding department. Here, Omega Feeders are employed to deliver coagulants, softeners, and taste-control chemicals to the settling basins and filter beds. Since the population being served varies from less than 15,000 to almost 30,000, the highly accurate rate adjustments of these Feeders are essential to the operation of the plant. For Bulletins and complete information on Omega water works equipment, address Omega Machine Company, (Division of Builders Iron Foundry), Providence 1, R. I.

BIF INDUSTRIES

OMEGA
THE LAST WORD IN FEEDERS

OMEGA

Every Inch
BUILT FOR DURABILITY



LAYNE OFFERS a wide range of fully illustrated catalogs and folders describing Layne Well Water Systems, Oil and Water Lubricated Vertical Turbine Pumps, Short Coupled Service Pumps, Cemented Water Wells, Irrigation Pumps, etc. Sent without obligation.

ALL Layne Well Water Systems are designed and built to give many years of durability,—and that durability extends into every part from motor base to well screen. Once installed according to Layne's own exclusive methods, these ground water supply systems have a record for giving extraordinary satisfaction over extremely long periods of time. This means that as an investment, Layne Well Water Systems always more than justify their cost.

Layne knows that without durability, all of their fine designing and high efficiency features would be lost. As the world's most widely experienced builder of ground water supply equipment, Layne knows what it takes to create durability.

Layne designs and builds complete well water systems, drills the wells and installs pumps to produce ground water for any purpose, — cities, factories, processing plants, etc. No charge is made for their study and recommendations.

For further information, catalogs, etc., address

LAYNE & BOWLER, INC.
General Offices Memphis 8, Tenn.

Layne

WELL WATER SYSTEMS

VERTICAL *Turbine* PUMPS

LAYNE ASSOCIATED COMPANIES

ASSOCIATED COMPANIES—Layne-Arkansas Co., Stuttgart, Ark. ★ Layne-Atlantic Co., Norfolk, Va. ★ Layne-Central Co., Memphis, Tenn. ★ Layne-Northern Co., Mishawaka, Ind. ★ Layne-Louisiana Co., Lake Charles, La. ★ Louisiana Well Co., Monroe, La. ★ Layne-New York Co., New York City ★ Layne-Northwest Co., Milwaukee, Wis. ★ Layne-Ohio Co., Columbus, Ohio ★ Layne-Pacific, Inc., Seattle, Wash. ★ The Layne-Texas Co., Ltd., Houston, Tex. ★ Layne-Western Co., Kansas City, Mo. ★ Layne-Minnesota Co., Minneapolis, Minn. ★ International Water Corp., Pittsburgh, Pa. ★ International Water Supply, Ltd., London, Ont. ★ Layne-Hispano Americana, S.A., Mexico, D. F. ★ General Filter Company, Ames, Iowa.

modernize—for greater capacity—economically with Rex Floctrol and Verti-Flo!

When increased demands exceed the capacity of your water treatment plant, you can bring your plant up-to-date . . . step up capacity . . . economically with **Rex Floctrols** and **Verti-Flo** Clarifiers. Installed in new or existing tanks, these efficient units provide greatly increased capacities . . . more effective results.

At the Fairmont, Minn., treatment plant for example, **Rex Floctrols,** installed in modernized tanks, and a **Verti-Flo** in an existing tank, made possible an increase in plant capacity from the originally designed capacity of 500,000 G.P.D. to 2,000,000 G.P.D. *without increasing the physical size of the plant.*

Tests show that the chemical reaction is complete within the Floctrol despite the extreme seasonal changes in water temperature.

The **Verti-Flo** equipment was installed in two existing rectangular settling tanks, providing for and efficiently handling 2,000,000 gallons daily, an increase of 1,500,000 gallons daily over the original designed capacity of the two conventional tanks. Detention time was reduced from 6.2 hours to 1½ hours, and solid removals were remarkably improved. Effluents were improved to the point where filter runs were increased 5 to 6 times.

Why not reap the benefits of this modernization for your plant? For complete details and informative literature, write: **Chain Belt Company,** 1610 W. Bruce Street, Milwaukee 4, Wisconsin.

Rex Verti-Flo Clarifier at Fairmont, Minn.

Rex Floctrols at Fairmont, Minn.

G. E. Basom, Manager
Water and Light Commission
Fairmont, Minnesota

CHAIN BELT REX COMPANY

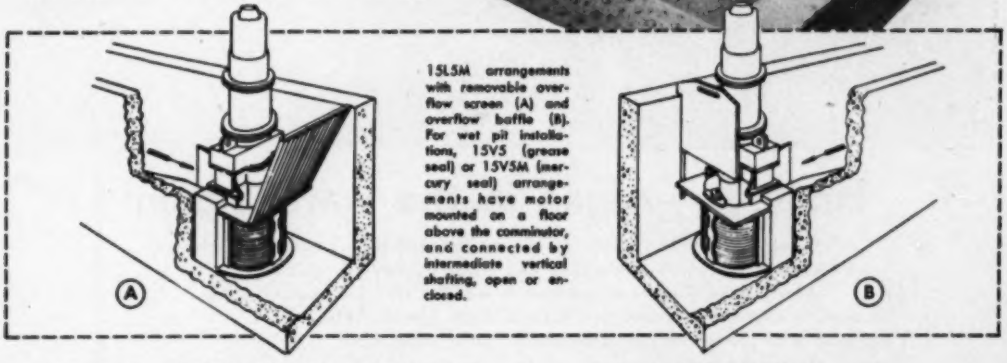
WATER TREATMENT EQUIPMENT

Another Worthington Development For Time- and Labor-Saving Sewage Treatment

THE ONLY COMMINUTOR WITH ALL THESE ADVANTAGES...

- **Easy installation in straight-flow rectangular sewage channels, new or old.**
- **Cutter racks quickly removable for sharpening or replacement, eliminating tedious individual cutter sharpening and adjusting.**
- **Provision for a mercury seal, for automatic protection of internal parts at unusually deep submergences. (Grease seal furnished as standard equipment.)**
- **Provision for overflow screen or baffle by means of a supporting flange.**

The 15C5 Worthington comminutor arrangement for continuous, automatic sewage solids cutting. This unit is designed for a .3 to 2.3 mgd flow range in a channel of 3 feet maximum depth. Standard grease seal supplied is suitable for water depths up to 22 inches.



15L5M arrangements with removable overflow screen (A) and overflow baffle (B). For wet pit installations, 15V5 (grease seal) or 15V5M (mercury seal) arrangements have motor mounted on a floor above the comminutor, and connected by intermediate vertical shafting, open or enclosed.

In many installations infiltration subjects comminutors to peak flows and submergences beyond their maximum capacities. Only Worthington comminutors can be supplied with both a mercury seal and an overflow screen or baffle to handle this problem.

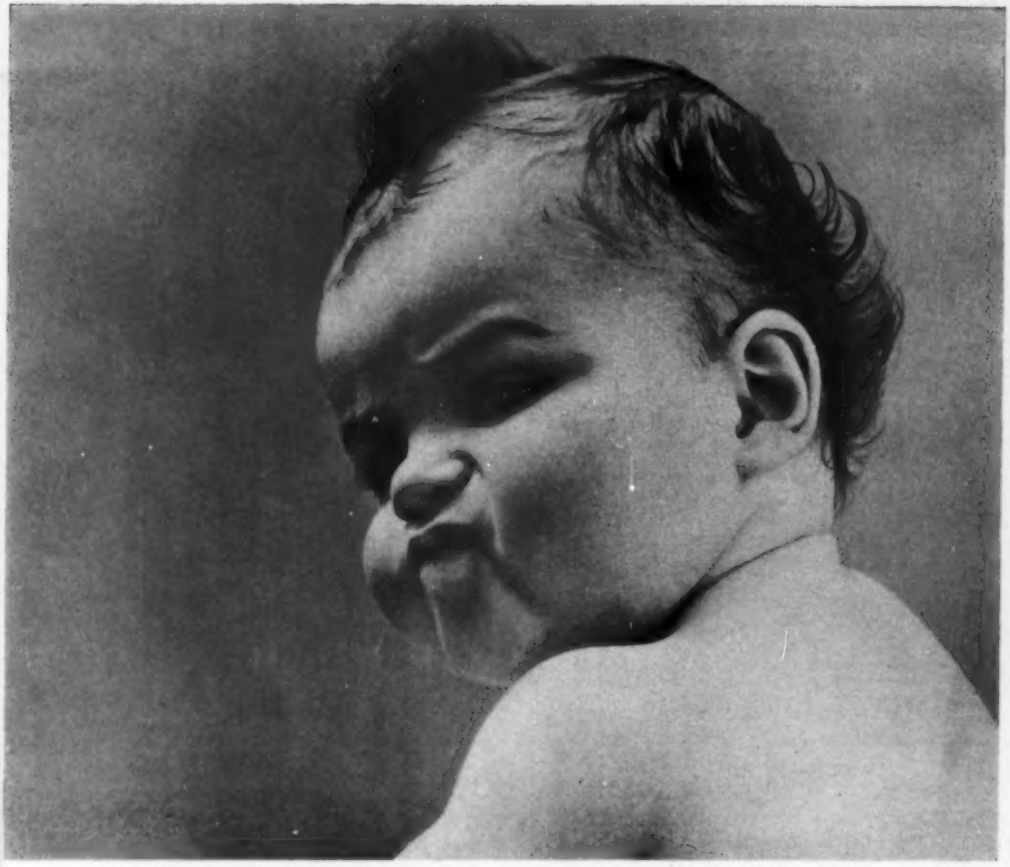
The mercury seal automatically protects the unit's internal parts up to a reasonable submergence. The gear head motor is mounted on a motor base extension pipe above high water level; channel depth may be over 3 feet. The removable overflow screen provides screening at the comminutor's overflow without causing troublesome upstream conditions, and occasional accumulations may be raked down into the unit. Or, an overflow baffle may be used to back the sewage up through the by-pass screen, preventing overflow.

Many Other Advantages

of the Worthington comminutor combine for rapid, continuous, automatic comminution — and for the long, trouble-free service life that proves *there's more worth in Worthington*. Write for bulletin W-2010-B3, and for drawings of arrangements best suited to your own application. Or contact our nearest District Office. *Worthington Pump and Machinery Corporation, Harrison, N. J.*

WORTHINGTON

W-441



Hmm . . . Algae in the water again!

Aqua Nuchar Activated Carbon can be used in two ways to eliminate troublesome algae which cause taste and odors in water supplies.

First, is the "blackout" method in which a slurry of Aqua Nuchar is used to exclude sunlight to eliminate algae growth. The second method is to physically remove algae by adsorption with Aqua Nuchar Activated Carbon.

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THIS METHOD OF ACCELERATING DIGESTION MAKES SENSE !

Four No. 500 P.F.T. Digester Heaters and Heat Exchangers serve 4 85' and 6 50' P.F.T. Floating Cover Digesters at Dayton, Ohio. L. C. Hoffman, Engineer.

It has been found that action of the methane producing bacteria is less deterred by temperatures above or below the optimum than by fluctuations in temperature. P.F.T. Digester Heater and Heat Exchanger units provide a safe, practical and economical means of maintaining sewage sludge undergoing digestion at an optimum temperature.

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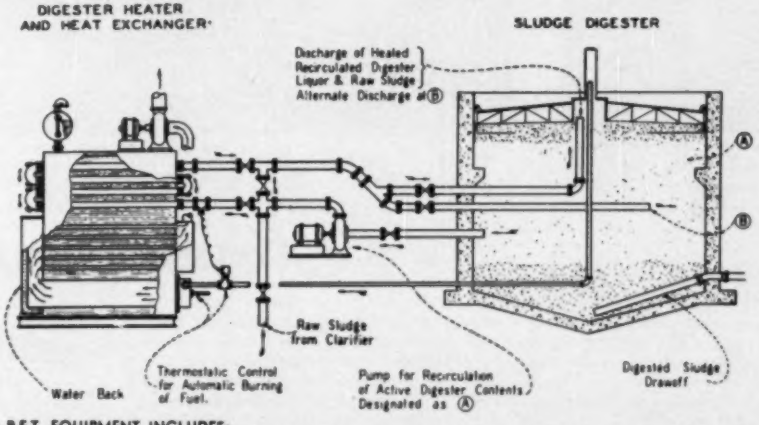
P.F.T. Digester Heaters employ methane gas from the digestion tank for fuel. P.F.T. Gas Engine Heat Exchangers employ heat from sludge gas engine jacket cooling water to keep the sludge at optimum temperature. A list of installations to date is available on request to Pacific Flush Tank Co., 4241 Ravenswood Ave., Chicago 13, Ill.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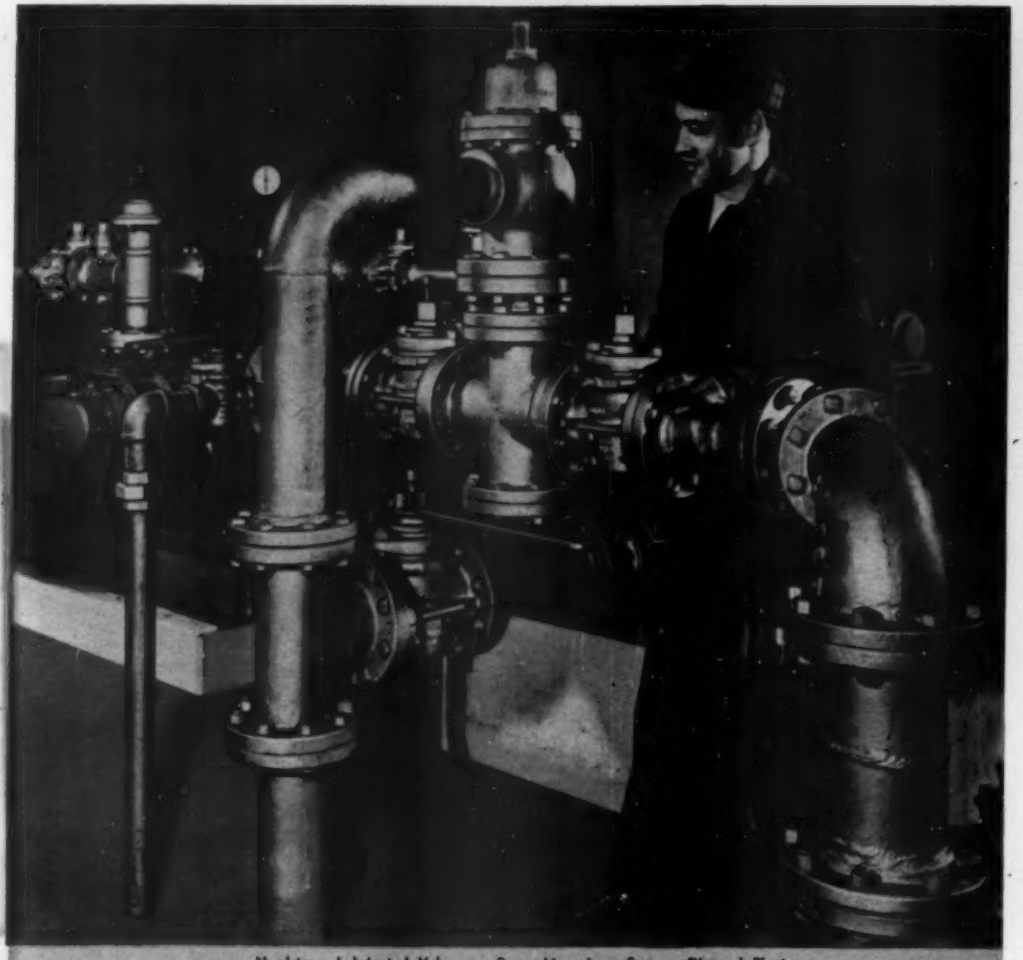
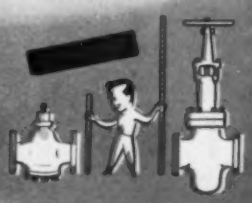


Nordstrom Lubricated Valves on Pump Lines in a Sewage Disposal Plant

MOST COMPACT VALVE SETTINGS

WITH Nordstroms

You'll save a lot of space and make your piping arrangements more compact when you design your sewage disposal plant lines with Nordstrom valves. And it's easier to maneuver flow when your valves are close together. Note the compactness of the above hook-up. It's neat, devoid of projecting valve yokes. Only a quarter-turn of the wrench completely opens or closes each valve, saving time and eliminating guessing whether the valve is fully closed. You eliminate hammer-blow and tugging. Automatic lubrication insures leak-free performance. The Nordstrom tapered plug insures against sticking.



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KEEP UPKEEP DOWN

COMBATING SEA and SEWAGE HAZARDS
BYERS WROUGHT IRON protects this outfall line

An early outfall line, still serving and in excellent condition after 38 trouble-free years, helped to write the specifications for a new outfall line recently installed by the Borough of Spring Lake, N.J. On the basis of this experience, wrought iron was selected for plus-protection against punishing corrosion encountered both from sea water, and from sewage.

Approximately 1350 feet long, this new outfall line was made up of 14 inch OD Byers Wrought Iron pipe, having a wall thickness of ½-inch. All joints were electrically welded and reinforced with 18 inch wrought iron sleeves, ½-inch thick, which were split and slipped over the pipe. As lengths were added, the line was pulled out to sea by a stationary hoist which had been set up on the beach line. Off-shore boats guided the outboard end of the pipe seaward. This installation was handled by Thomas Procter Co., specialists in outfall work.

WHY WROUGHT IRON LASTS

This notch-fracture test specimen illustrates the unusual fibrous structure of wrought iron which is responsible for the unusual corrosion and fatigue resistance of the material. Tiny fibers of glass-like silicate slag, distributed through the body of high-purity iron, distribute local strains, halt and disperse corrosive attack, and discourage pitting and penetration. They also anchor the initial protective scale, which shields the underlying metal.

Sewage outfall lines encounter severe corrosive conditions. Inside, sewage sets up an aggressive action, while salt water attacks the outside of the line. Add to this the abrasive action of sand and the constant stresses imposed by current, tide and the moving valleys that are carved in the ocean floor and you have a team of destructive forces that sends many an outfall to an early grave *unless* the right pipe is used for the service. Wrought iron has been used in a number of outfall applications, and established excellent durability records for this service.

Our bulletin, WROUGHT IRON FOR SEWAGE TREATMENT AND DISPOSAL INSTALLATIONS is yours for the asking.

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90% at 1/4 gpm

For an accurate test YOUR TEST BENCH SHOULD *not* FILL THIS BOTTLE IN LESS THAN 1 MINUTE

IF IT DOES — METERS WILL LOSE REVENUE

Yes, you should test ⅝" meters at ¼ gpm—because surveys show that 13% of all water passing these meters is used at that rate. A flow of ¼ gpm, unaccounted for, unpaid for, wastes over 10,000 gallons per month per meter! Check the low flow rate on your test bench by simply running the test water into a quart milk bottle. If the bottle fills in less than a minute, the rate is too high.

In that case... the Neptune Rate-of-Flow Indicator, a simple inexpensive device, can be easily attached to modernize your test bench. It enables you to establish test rates with accuracy... to stop loss of water revenue.

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WATER & SEWAGE WORKS

VOL. 98, NO. 3 • A GILLETTE PUBLICATION • MARCH 1951

Preparing for Atomic Eventualities

Duty of Water Works Management, If for no Reason Other than to Create Public Confidence.

by M. B. CUNNINGHAM, *Sup't. & Engineer, Dept. of Water & Sewerage, Oklahoma City, Okla.*

A FILM being shown on Civil Defense and the Atomic Bomb, cautions people not to drink water after an atom bomb burst, until the water is pronounced safe to drink.

After seeing this film, we, in Oklahoma City, felt that it was time to get the answers to some questions which we had not been able to obtain satisfactory answers to. The State Health Department and the U.S. Public Health Service advised that the detailed information concerning the effects of the atomic bomb on water, and the methods for the removal of radioactive materials, and detailed information concerning instruments to detect radioactive count of water, had not been released to them by the Oak Ridge Laboratories.

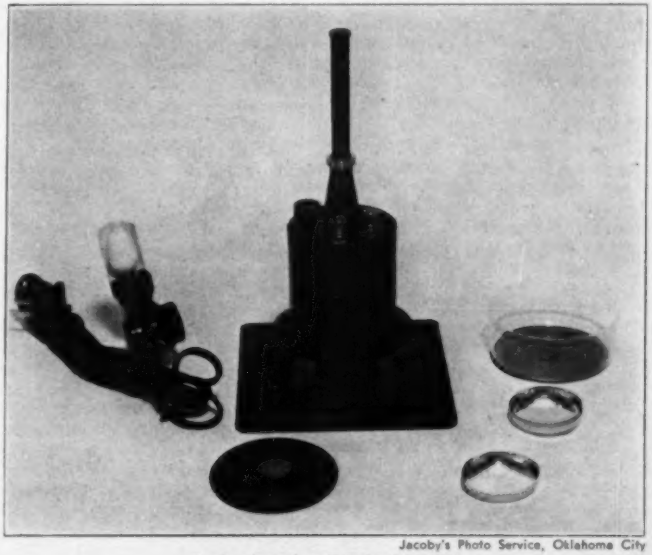
I felt so strongly that this information should be made available to us, that the National Laboratories at Oak Ridge were contacted. Result was that we received an invitation for a representative group to come to Oak Ridge for a 2-day conference. The group I took with me consisted of: Frank S. Taylor, my Chief Chemist and Assistant Supt.; George Reid, Professor of Sanitary Engineering at the University of Oklahoma, who had previously worked at Oak Ridge and had done some research work on radioactive wastes; and John Smouse, representing the Oklahoma State Health Department.

We received a very cordial reception at Oak Ridge, and all of our questions were answered to our entire satisfaction, together with a great deal of detailed information.

The specific items we requested detailed information on, can be classified under three general headings:

1. Radioactive effects of the atomic bomb burst on the Water System.
2. Radioactive materials getting into a raw water reservoir, and how to remove this radioactive material?
3. Instruments suitable for the average water-works operator to use in detecting the presence of radioactivity in water.

In the discussion of each of these points, we had a number of conferences with Department Heads and members of their staff at the various Laboratories. We are especially indebted to Dr. K. Z. Morgan, Director of Health Physics Division, Oak Ridge National Laboratories; Dr. Roy J. Morton, Waste Disposal Research Section; Dr. George G. Monov, Isotopes Division, Atomic Energy Commission; Ralph T. Overman, Chairman of Special Training Division, Oak Ridge Institute of Nuclear Studies; Dr. Conrad P. Straub, Health Physics Division, and members of the staff of the Laboratories, especially those connected with instruments.



Jacoby's Photo Service, Oklahoma City

Landwerk Analysis Unit, Model L-75-A

Two of which have been purchased for Oklahoma City's two Water Treatment Plants and one for the Sewage Treatment Plant.

Tracerlab's Laboratory Monitor SU-3A

This picture shows the Monitor equipped with a Geiger Tube. When this tube is submerged the unit monitors continuously for Beta and Gamma activity. To monitor for Alpha activity, also, a second unit is employed with an Alpha Detector Probe plugged-in in place of the Geiger Tube.

Effects of Atomic Bomb Burst on Water Systems

Discussing the first point, concerning the radioactive effects of atomic bomb burst, there has been considerable information published on this subject and it is obtainable through the U. S. Government Printing Office, Washington, D.C., for a nominal charge. These are specific bulletins, put out by the National Security Resources Board and the U. S. Atomic Energy Commission. Your local Civil Defense Director has been supplied with copies of these and other available publications.

Generally speaking, we were advised that an A-Bomb burst similar to the one used in Japan, occurring on a clear day and where the burst occurs 2,000 feet above the ground, there is very little fall-out of the radioactive material, and therefore workmen could go into the areas near the destroyed sections, and close the water main valves, at work periods of two hours at a time, without taking undue risks.

Where an aerial burst occurs during rainfall or snowfall, the area is likely to be heavily contaminated. In such case monitoring the area by the use of Geiger Counters will be necessary before workmen and rescue operations can safely proceed.

We were advised that it be taken for granted that, so far as radioactivity is concerned, the water in the mains would remain safe. Water in the home, in hot-water tanks would be safe for use, and water in elevated storage reservoirs, which are covered, would be usable.

We were glad to get this information, since in case of atomic bomb bursts, almost every home would at least have an emergency drinking water supply in their hot-water tanks.

How to Remove Radio Activity from Reservoirs

In case of rainfall at the time of the bomb burst, raw-water reservoirs could become radioactive insofar as the solids in the water are concerned.

The distribution of radioactive materials from an airplane was discounted as very remote, and not likely to occur.

If the water in the reservoir becomes redioactive, the removal of this activity was of great interest to us. We had a four hour discussion on this subject with Dr. Conrad P. Straub, who is handling a great deal of research on this subject, and recently gave a paper entitled: "Recent Developments in the Treatment and disposal of Radioactive Waste Liquors," which he presented on December 29, 1950 at the 117th meeting of the American Association for the Advancement of Science, in Cleveland.

We were advised that the radioactive components can be reduced to the necessary emergency low level, by use of the regular water softening procedure such as we use here in Oklahoma City. However, in addition to the use of lime, and maintaining a pH value of not less than 10.2, copper, silver, or carbon, must also be used. The use of chlorine does not affect any reduction in the radioactive solids. The emergency low level of radioactive materials in drinking water which can be used for a week and probably for a much longer period has been established as 10^{-2} Microcuries per cubic centimeter. Peacetime levels established are of the order of 10^{-7} Microcuries per cubic centimeter, the maximum permissible concentration of mixed fission products in water.

There has been a considerable amount of research on the use of ion-exchange for the reduction of the radioactive solids in drinking water, but we have been unable to obtain additional information on this subject. A recent newspaper article did comment on the report that an ion-exchange container for home use had been developed; and indicated that satisfactory progress was being made on the development of larger installations, although at the present time, I am not sure whether such ion-exchangers would be capable of regeneration. Additional information is desirable on such exchangers, particularly in those areas where water softening plants are not available.

Those cities and towns using wells, and having a closed system, appear to be in a very favorable situation. We were advised that the research had particularly indicated that no trouble whatsoever was contemplated from atomic bomb burst and radioactive materials in connection with such supplies.

Instruments for Detection of Radioactivity in a Water Supply

Instruments will be needed by those Water Departments located in areas where an atomic bomb is most likely to be used, due to location of important industry or military installations.

The Oklahoma City Water Department is purchasing two Geiger Counters, which are being bought on specifications developed by the Federal Civil Defense authorities. Also, each of our other local Utilities are making smiliar purchases. We shall train our personnel, in cooperation with the other Utilities, so that in case of an atomic bomb burst, we will have teams for monitoring areas where our workmen must enter in order to close valves on the distribution sections of the system, in order to restore water pressure to the balance of the city.

One of the most important instruments that we were seeking for water-

works use was one that would be sufficiently simplified to make it useful to the average Water Department for the detection of radioactivity of water. We were fortunate to find exactly what we feel will give us the service needed. This is a brand-new instrument, which will determine the emergency level of radio-activity. The instrument sells for approximately $85.00, and is the only one of its kind that we know of. Known as the "Landsverk Analysis Unit, Model L-75-A", it is available through the Landsverk Electrometer Company, Pippin Road, Cincinnati 31, Ohio.

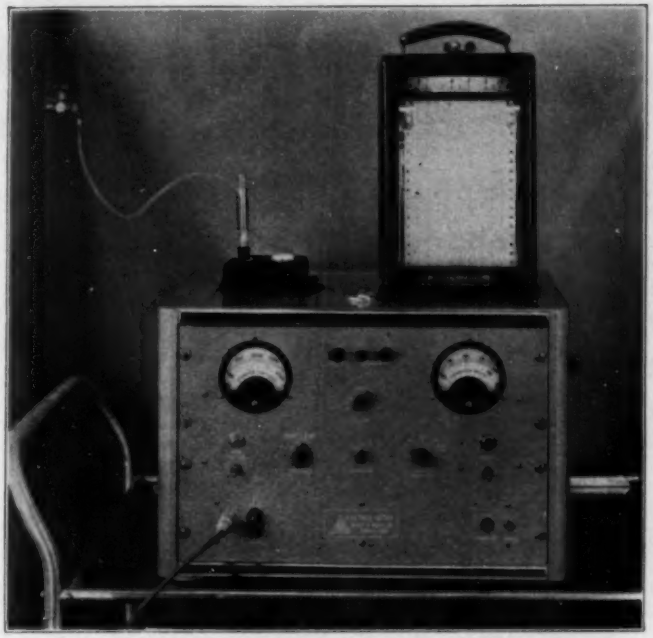
As evidenced by the accompanying illustration, this is not a complicated instrument and detection of radioactivity is made direct on a quantitative basis from a sample of water. We have already received one of these instruments, and have two additional instruments ordered, so that we will have one for each of our Water Treatment Plants and one for our Sewage Treatment Plant.

There are also instruments available at costs from $545.00 to $2500.00 for the *continuous* monitoring and recording of radioactivity of filtered water from Tracerlab Inc., 130 High St., Boston 10, Mass.

We understood that two other companies are offering similar equipment. These are, Radiation Counter Laboratories, Inc., 1844 West 21st Street, Chicago 8, Ill. and Nuclear Instrument & Chemical Corp., 223-233 West Erie St., Chicago 10, Ill.

Water Works Management's Responsibility

We were advised at Oak Ridge, that for the past year or more, several invitations have been extended to each of the Governors of the States to designate one or two individuals to come to Oak Ridge and receive special training in the use of instruments, and related matters.



Continuous Recording Radiological Water Control Monitor
Offered by Radiation Counter Laboratories Inc. of Chicago. Similar equipment is offered by other firms listed in the text.

The Water Departments can find assistance by making inquiry through the State Health Departments, State Universities, or Medical Schools, and you will find one or more individuals in your own State, who have received special training at Oak Ridge. These individuals will be able to assist you on your special problems.

We, in Oklahoma City, feel that this is the time that we should train our employees in the use of radio activity instruments, and give them the training which will thoroughly acquaint them with the Civil Defense Program so that, if and when an emergency does arise, we will have trained personnel to cope with the problem.

I feel that the management of water-works has a responsibility to the people of his community, in that we should train our employees to the extent that the public will be aware that their Water Department has the equipment and the trained personnel to protect the water supply of the community come what may.

At this time it is quite important that the public be assured that water works management is prepared to see that the water supply will not be "poisoned" by atomic radioactive products or byproducts.

BEHLMER MADE SUP'T. OF WATER BY FARGO

Succeeds Ora Ayliffe, Retired

Harold H. Behlmer, former assistant Superintendent of Water Works at Fargo, N.D., has been made superintendent to succeed Ora C. Ayliffe, retired.

Mr. Ayliffe's tenure of service with the Fargo Water Department was almost 39 years. Mr. Behlmer has a service record of 34 years.

Mr. Behlmer, a native of Crookston, Minn., has served as assistant city engineer, served in World War I in the 23rd Engineers in France and returned in 1919. He saw more war service in World War II and again returned to Fargo in 1943 to assume the duties of assistant superintendent under Mr. Ayliffe.

Mr. Behlmer has been active in the North Dakota Water and Sewage Works Conference and was recently elected president of this Conference. He is also president of the Engineers Club of Fargo.

Mr. Ayliffe, retiring at the age of 77 years, had served Fargo as superintendent of purification and later general superintendent for almost 39 years. He came to Fargo from Lorain, Ohio, in 1912, to take charge of the new filtration plant. Starting as a meter foreman in Lorain, Mr. Ayliffe became interested in water purification, took special courses in water purification to equip himself for the position of sup't of filtration. He is a veteran of the Spanish American War and a past exalted ruler of the Elks Club of Fargo. He is a past president of the Engrs. Club of Fargo and the N.D. Water and Sewage Works Conference.

Water Fluoridation at Charlotte, North Carolina*

Results of First Year's Operation

by ROBERT S. PHILLIPS, *Supt. of Water and Sewage Plants, Charlotte, North Carolina*

THE practice of fluoridation of water supplies in the South, as well as in many other sections of the United States, is comparatively new, the earliest program in this section having only begun in 1949 at Charlotte, N. C.

Despite the fact that from many quarters came expressed opposition to water fluoridation, the American Water Works Association took the lead in 1949 in approving the policy of water works participation "in those communities where a strong public demand has developed—," and where the fluoridation procedure has full approval of various interested health authorities and societies[1]. In 1950 the State and Territorial Dental Health Directors and the United States Public Health Service went on record as "recommending" and "encouraging", respectively, the fluoridation of public water supplies.

Recalling his earlier stand of advocating fluoridation rather than taking a stand of "watchful waiting" and thus denying the potential cumulative benefits to a generation of young persons during these years, Editor Linn H. Enslow[2] states in a follow-up editorial in the Nov. 1950 issue of *Water & Sewage Works*—

> "We believe that the time it as hand for all existing 'hold out' State Health Departments, which have been adhering to the now outmoded policy of 'watchful waiting' during the period of controlled demonstrations at selected locations, to follow the pattern of revised policy, which has been adopted by the New York and Michigan Health Departments.
>
> "And, based on overall experiences to date, we believe that there should no longer be any hesitancy on the part of water works managers to go forward wholeheartedly with water fluoridation in any situation wherein local demand for such enrichment of water with caries suppressing fluorides comes into evidence."

In 1949, Faber[3] reported that a total of 17 public water supplies were being fluoridated. In a recent survey, Stadt[4] found 42 towns and cities with fluoridation programs underway and estimates that more than double this number will probably be in operation before the end of 1950. Just recently Lynchburg became the first city in Virginia to receive approval of its fluoridation program. Many other cities within the South have similar programs under consideration.

Charlotte, the first city in the Southeast to adopt fluoridation, inaugurated its demonstration, on an experimental basis, April 1, 1949, but the actual addition of fluorides was deferred until April 25, 1949. Except for the period between May 20 and August 3, 1949, when the project was temporarily suspended, the program has been in continuous operation for more than a year.

What to Expect

Charlotte's program is entirely a locally sponsored and directed project. All costs of the demonstration, other than labor for handling and controlling the application of fluorides, are paid for by the Health Department out of appropriated funds. Fluoridation is under direction of the City Health Department as the responsible controlling agency. The Charlotte Water Department is simply the operating agency which applies the dosage of fluoride as prescribed and directed by the City Health Officer and makes routine analyses and conducts studies looking toward improvement and economies.

While April 1, 1949 was proclaimed as "Fluoridation Day" by the Mayor and a public ceremony was held at the filter plant, at which time the chemical feeder was started, the actual application of sodium fluoride was deliberately delayed until April 25th. This period between April 1st and 25th led one Charleston (S.C.) newspaper to editoralize on "Furyonation" due to the fact that Charlotte newspapers had given wide publicity to the literally dozens of complaints which had poured into the Health and Water Departments daily concerning killed goldfish, horrible tastes, ruined photographer's films, stained laundry, etc. These, and many more undesirables were attributed to fluoride! At the height of public reaction the press sought to correct false impressions by announcing that up to that time no fluoride had been added to the water! Then, without further announcement, fluoridation was immediately begun and no further complaints were received for about a week when suddenly the entire ice manufacturing industry reported a severe increase in cracking and shattering of manufactured ice. As a result, the industry requested that the fluoridation program be suspended in order to provide time in which to investigate the problem and seek a remedy of the reported trouble if it was found to be caused by fluoridation. This request was granted and the program was suspended on May 20th, after only about three weeks of actual operation.

Dr. Z. M. Stadt and the writer proceeded immediately to investigate the problem with the cooperation of the ice manufacturers. A summary of the results of this work has been published[5]. Briefly, our studies revealed that when our water supply was fluoridated, a termendous increase could be expected in cracking or shattering of the manufactured ice. On the other hand with the addition of inexpensive "Anti-crack" (so called ice-tempering tablets, many of which are nothing but ammonium chloride) to the fluoridated water, the percentage of cracked ice could be reduced to near normal. The results of these investigations were reported to the Charlotte Board of Health and to the ice manufacturers, with the recommendation that fluoridation be resumed. The recommendation was approved and resumption of fluoridation was ordered August 3, 1949. Since that date, no significant interruption of fluoridation has occurred and the program has proceeded without complaints either from industry or the public.

The City Health Officer has directed that we apply a dosage of fluoride-bearing chemicals sufficient to bring the final level of fluoride (in

*This paper, presented before the Virginia Section of A.W.W.A. by the author, has been released by the Association for publication in *Water & Sewage Works*.

terms of the fluoride ion F^-) in the treated water to that shown in Table 1. By maintaining these amounts of fluoride in the drinking water it is expected that dental caries attack rates will be reduced by at least 50% among children up to 8 years of age. It will be noted that the end quantity of fluoride is maintained at a lower level in the warm-weather season when more water is being drunk by consumers.

An elaborate study program has been underway by the Health Department for several years under the direction of the Dental Health Officer. More than 15,000 pre-fluoridation oral examinations and tests were made, including some 11,000 dental examinations of the 5 to 19 year group of Charlotte students. In addition, comparative studies have been or will be made between Charlotte and other nearby communities in North Carolina; between Charlotte-born and migrants to Charlotte from non-fluoridated areas; and between Charlotte and other communities throughout the country which are fluoridating their water supplies. These statistics will be used in future years for a comprehensive evaluation of the effects from fluoridation at Charlotte.

Photos, Courtesy Purser & London of Charlotte.

Omega Gravimetric-Type Fluoride Feeder

Note weight recording unit on top of this precision feeder which features feed control on basis of governed loss-in-weight. View with door open shows solution chamber and dissolving agitator.

Source of Fluoride

At present both sodium-fluoride and sodium silico-fluoride are available on a commercial basis for the fluoridation of water supplies. These can be obtained in several grades, densities and in various types of packages. In Table II are listed some of the grades and characteristics of these two fluoridation chemicals. The author has not had any experience with other fluoridation chemicals, such as Hydrofluoric Acid.

In Charlotte we have used the 95% Nile Blue (approx. 50 lbs./ cubic feet), the 95% White (20-60 mesh) sodium fluoride and the 96% Nile Blue sodium silico-fluoride. All of the finely ground chemicals produce considerable dust when the hopper of the chemical feeder is charged.

The coarse grade 95% white sodium fluoride (20-60 mesh) has been fed without difficulty through our dry-feed equipment during the past summer and fall. We have, on test, been able to feed more than 80% of our feeder's capacity with a dissolving time of approximately 4½ minutes in the solution chamber. This coarser grade of sodium fluoride produces considerably less dust and appears to feed somewhat more uniformly.

We have tried each type of package currently available. Our preference is for the so-called "Leverpaks," heavy paper drums weighing 100-125 lbs. net each, with dust tight lids. These can be easily handled by one man and can be stored more readily than the 375 lb. barrels.

We feel that, as a safety measure, the artificially colored grades are worth the slight extra cost.

Safety Measures in Handling

Inasmuch as fluoride chemicals are irritating to the skin and mucous membranes, and are poisonous if taken internally, each operator and operator-helper has been thoroughly indoctrinated regarding these properties and the proper procedures to be followed when handling. In addition each individual is provided with a separate pair of rubberized gloves and cotton-pad type respirators, which are worn when the chemical is added to the chemical feeder. All personnel have been cautioned to remove any dust from the skin by bathing or washing immediately after contact. Since the feeder capacity is such that only one charging per day is required, actual exposure time to dust is relatively short. No skin disorders associated with handling of the fluorides have been experienced.

Feeding Equipment

The fluoride chemicals are applied to the water through an Omega Loss-in-Weight Type Gravimetric Feeder, Size No. 1, equipped with a built-in dust remover unit and connecting chute to the 500 lb. capacity feeder hopper. A 24-hour recording chart showing the amount of the chemical in the hopper at all times provides a permanent record of application by the feeder. Rates of feed can be varied between 0.3 and 30 pounds per hour. Suitable alarms are provided for the purpose of notifying the operator of over or underfeeding rates. The fluoride is dissolved in a 23-gallon steel dissolving chamber, lined with cypress and asphaltum. From this point the water solution of the chemical flows by gravity through a two-inch acid and alkali-resistant rubber hose to the combined filter effluent. The point of application is immediately following addition of hy-

Table I

SCHEDULE OF FLUORIDE LEVELS TO BE MAINTAINED IN CHARLOTTE WATER

(As Directed by City Health Officer April 22, 1950)

Period	ppm Fluoride*
Jan. 1 to March 15	1.10
March 15 to April 15	1.05
April 15 to May 15	0.95
May 15 to June 15	0.90
June 15 to July 1	0.70
July 1 to Aug. 1	0.60
Aug. 1 to Sept. 1	0.65
Sept. 1 to Oct. 1	0.75
Oct. 1 to Nov. 1	0.85
Nov. 1 to Dec. 1	0.95
Dec. 1 to Jan. 1	1.05

*In terms of the fluoride in F^-.

drated lime for reducing the corrosivity of the filtered water.

A clear well provides intermediate storage prior to final pumping to the distribution system. This allows time for thorough mixing of all chemicals and smooths out possible variations in fluoride content of the treated matter.

Close checks have shown conclusively that the chemical feeder will deliver extremely accurate dosages, well within the guaranteed accuracy of one per cent (1%). In a twelve-month period of continuous operation, we have had an unaccounted loss of chemical from *all causes* of only slightly more than 1%.

Seasonal Adjustment of Dosage

The A.W.W.A. policy and procedure statement[5] recognizes the need for additional experimental studies on a geographical basis in order to determine the optimum concentration of fluoride needed under various climatological conditions. The committee report states:

> "It is quite possible that more than 1 ppm might be required in areas having a low mean annual temperature such as the Dakotas, while 0.5-0.6 ppm might suffice where climatological conditions are reversed as in the deep South and Southwest."

There is some epidemiological data to support the belief that dental fluorosis may occur where the fluoride level in the water supply is less than 1 ppm. In December, 1946, Dean[10] made an investigation on the epidemiology of dental fluorosis in two places in Georgia. He found that the incidence was 12.6% and 9% in cities where the fluoride content of the water supplies were 0.7 ppm and 0.5 ppm respectively. Faber[3] notes a report from New Mexico where fluorosis occurred from a water supply containing but 0.7 ppmF^-.

In Charotte we have lowered our overall average dosage from the original level prescribed of 1.10 ppm. to an average between 0.8 and 0.9 ppmF^-. We have further attempted to refine the technic on a seasonal basis by varying the fluoride level between 0.6 ppm in the hottest part of the year, to 1.10 ppm during the winter, when water intake by the individual is expected to be lower. These dosages were prescribed after many water usage records had been studied and discarded. Water pumpage records were of little value, since such factors as air conditioning, lawn sprinkling, general economic conditions are all variable. School records of water usage were of no value since water consumption drops to virtually nothing during vacation months. On the other hand it is believed that the records of water used by the bottlers of soft drinks provides an excellent clue to the seasonal liquid intake habits of our population, since there is a direct proportional relationship between overall water use and the finally bottled product. Water usage records of the five largest Charlotte bottlers over a three year period were tabulated and combined. In addition we were able to obtain from a local bottler of mineral springs water seasonal records of sales which provided something of a factor. Graphically these two records parallel Charlotte's mean average air temperature curve rather closely. Fluoride levels prescribed therefore somewhat approximate these curves, but in an inverse ratio. These levels are not considered the "last word" and may be revised in the light of further water intake studies which are now underway by the Charlotte Health Department.

The question of water intake by individuals (especially children) as related to various climatological conditions, remains to be answered. Studies are being made by our own health department and in other parts of the country. Sometime in the future these data will be evaluated and undoubtedly published.

Sampling and Analyses

When fluoridation of our water supply was begun, extensive daily sampling of the distribution system at widely separated points was inaugurated. Plant samples were taken three times daily. All samples were individually tested for fluoride and a representative number were shipped to the State Laboratory for parallel testing. We continued this number of tests for nearly a month.

These data showed conclusively that no significant loss or build-up of fluoride was taking place at any point sampled. Further, *under our conditions* we were able to show that plant samples more than once daily were unnecessary.

Since August, 1949, with the approval of the controlling authority, we have been testing daily samples from:

1. Filter effluent prior to application of fluoride.

2. Pump discharge to distribution system, and samples, 5 to 7 times weekly, from:

1. Pooled sample taken from five points on distribution system.
2. Health Department.
3. Morris Field.

A representative number of the above samples are collected in duplicate and shipped to the State Laboratory and other cooperating laboratories for parallel testing.

Table III

FLUORIDE RESULTS

Laboratory Analyses Charlotte, N.C.

(Averages Sept. 1, 1949—Aug. 31, 1950)

	Days Sampled	F- ppm.
Sodium Fluoride Added (As 43% F^-)	.....	0.90
Fluoride in Filtered Water*	359	0.04*
Fluoride in Plant Tap Samples	365	0.95
Fluoride in Pooled Distrib. Samples	235	0.93
Fluoride in Health Dept. Samples	319	0.92
Fluoride in Morris Field Samples	353	0.93

*Before fluoride addition.

Table III shows yearly averages of analytical results for the first year of continuous operation (Sept. 1, 1949-Aug. 31, 1950).

Except as will be discussed later, our laboratory uses the Scott Modification of the Sanchis Method, without distillation[12], for the determination

Table II

GRADES AND PROPERTIES OF TWO TYPES OF FLUORIDATION CHEMICALS

Chemical	Min. Purity %	Approx. F^- Cont. %	Solubility %	Color	Pounds per cu. ft.	Degree of Fineness
Sodium Fluoride	90	41	4.2	White	38	Extr. Fine
	95	43	4.2	White	38	Extr. Fine
	90	41	4.2	White	50	Very Fine
	95	43	4.2	Blue	50	Very Fine
	90	41	4.2	White	75	Fine
	95	43	4.2	White	90	Coarse
Sodium Silico-fluoride	96	58	0.8	White	72	Fine
	96	58	0.8	Blue	72	Fine

Note—All of above grades may be obtained packed in multi-wall paper bags of 100 lbs. each, in paper lined wooden barrels of 375-425 lbs. each and in fibre drums (Leverpaks) of 100-125 lbs. each.

of fluoride. This method depends on the decolorization of a zirconium-alizarine lake by the fluoride ion. It is a fairly rapid test, the reaction of which can be completed in one hour. We have found that by suitable modification and by taking reasonable precautions such as maintaining chemically clean glassware, temperatures as recommended, and with the use of exactly matched long form nessler tubes, the test can be quite reliable. Based on an experience of literally hundreds of parallel readings, made by independent observers, we believe that the test is accurate, with our water, to a greater degree than is implied by "Standard Methods"—perhaps as close as .05 ppm and certainly well within 0.1 ppm. This degree of preciseness can only be achieved, however, if all recommended precautions are rigidly observed.

All samples are tested in the Water Department laboratory. Plant samples are analyzed by our personnel. The Health Department provides technical assistance for testing distribution system samples.

We have found that free available chlorine interferes wtih the fluoride test[9]. Harris[9], Todd[9] and Taras[9] have also reported this effect. The action of free chlorine is somewhat similar to that of the fluoride ion and results in high false fluoride readings. The effect may be considerable even with as little as .05 ppm free available chlorine. With larger amounts of free chlorine, false readings are correspondingly greater.

With the approval of the controlling authority we are therefore using a simple modification of the Scott-Sanchis method. Each sample of water is dechlorinated with sodium thiosulfate prior to test. There is no apparent interference to the test by the small amount of thiosulfate required.

It has been our policy to maintain close and continuous checks on the application of fluoride to the water supply. In addition to the entry of pertinent information or regular daily and monthly operating and laboratory records and the feeder chart's permanent record, we have initiated a weekly report form, mimeographed on letter size sheet. Spaces are provided for recording a daily summary of operation data, chemical inventories, and results as shown by analyses. Copies of these reports are forwarded weekly to the State and City Health authorities.

Our first twelve complete months of operating results are shown on Table IV. It will be noted that the natural fluoride present in the unfluoridated filtered water is only .04 ppm on an average. Dosages of sodium fluoride (95%) have varied between 20.6 lbs. per MG at 1.1 ppm to 10.7 lbs. per MG at 0.6 ppm final fluoride levels. The average has been 17.1 lbs. per MG for the full 12-month period.

Sodium Fluoride vs. Silico-fluoride

During this fall the Health Department obtained approval from the N.C. State Health Officers for the trial of sodium silico-fluoride on an experimental basis. The test run is not quite completed. Final results are, therefore, not available.

As pointed out previously this chemical contains appreciably more fluoride per pound than does sodium fluoride. Further, it is considerably cheaper although the price has risen somewhat recently. In spite of this it has been estimated that chemical costs at Charlotte would be reduced nearly 70% if the silico-fluoride is used.

Our experience with the feeding of sodium silico-fluoride has been similar to that reported in *Water & Sewage Works* by Zufelt[10] at Sheboygan. The material feeds similarly to the finely ground sodium fluoride. Dust conditions are about the same as for the finely ground sodium fluoride. Handling is identical with that of sodium fluoride.

While the price of this chemical is considerably less than sodium fluoride there are several comparatively minor equipment and operating cost factors which should be balanced against the lower price. From our observations these are:

(a) Sodium Silico-fluoride is considerably less soluble and will in most cases require larger dissolving chambers.

(b) Sodium Silico-fluoride is decidedly acid in water solutions. Acid resisting dissolving chambers and fittings will be required throughout.

(c) In the case of extremely soft waters such as at Charlotte, the pH of the treated water is lowered to a measurable extent and additional final lime or other alkali will be required for readjustment.

It is not intended to imply that these balancing factors will change the broad picture, but they should be considered.

Cost of Installation and Chemicals

The total cost of our fluoride feeding equipment, including installation, was $3,497.25. In addition about $75 was spent on additional laboratory equipment. Our chemical costs have averaged $12.24 per 100 lbs. delivered to Charlotte. The total chemical cost for the 12 month period (Sept. 1949-August 1950 inc.) was $11,413.80. Miscellaneous costs for supplies and maintenance of feeding equipment have been less than $100. Our cost per million gallons has averaged $2.13. The per capita cost per annum has averaged slightly above eight cents (8c). All of the above annual cost figures are somewhat lower than originally anticipated, but this is primarily due to decreased dosages. If sodium silico-fluoride is used in place of sodium fluoride our chemical costs

Table IV

FLUORIDATION CHARLOTTE WATER SUPPLY OPERATING RESULTS

(September 1949—August 1950 Inc.)

Month	Water Treated M.G.	Pounds Sodium Fluoride Used	Parts Per Million as Fluoride—F⁻ Rate Setting Feeder	Rate Actual Applied	Untrtd. Water	Plant Tap	Dist. Sys.	Health Dept.	Morris Field
September	437.424	8,878	1.05	1.05	.02	1.06	1.05	1.01	0.98
October	446.521	9,198	1.08	1.06	.03	1.08	1.06	1.07	1.06
November	408.858	8,491	1.08	1.07	.03	1.10	1.08	1.05	1.04
December	439.061	9,005	1.08	1.06	.03	1.08	1.06	1.03	1.08
January	423.234	8,846	1.10	1.08	.04	1.13	1.13	1.15	1.12
February	373.901	7,749	1.05	1.07	.04	1.09	1.11	1.11	1.14
March	421.197	7,520	0.94	0.92	.02	0.99	0.97	0.98	1.01
April	423.599	5,722	0.71	0.70	.02	0.74	0.74	0.71	0.71
May	478.575	7,893	0.87	0.85	.04	0.93	0.91	0.90	0.89
June	502.368	7,236	0.76	0.74	.06	0.82	0.81	0.82	0.82
July	499.214	5,283	0.56	0.55	.06	0.65	0.62	0.62	0.64
August	548.509	6,519	0.63	0.61	.06	0.68	0.67	0.64	0.63
TOTAL	5,401.352	92,340*							
AVERAGE			0.909	0.897	.038	0.946	0.934	0.924	0.927
WEIGHTED AVERAGE			0.892	0.882					

*Note—In addition, 951 lbs. were unaccounted for in losses from all causes, a percentage of slightly above 1%.

should be reduced more than 60%. All annual costs above are exclusive of fixed capital charges, depreciation, and labor required for supervision, operation and technical control.

Sources of Fluoride Bearing Chemicals

For the benefit of those who may be seeking sources of fluoride-bearing chemicals the following list is given:

Sodium Silicofluoride:

Blockson Chemical Co., Joliet, Ill.
E. I. Dupont De Nemours and Co., Inc., Wilmington, Del.
U.S. Phosphoric Products Co., Tampa, Fla. (Div. Tennessee Corp.)
Henry Sundheimer Co., 103 Park Av., New York 17, N. Y.
Davison Chemical Co., Baltimore, Md.
Faesy and Besthoff, 325 Spring St., New York 13, N. Y.

Sodium Fluoride:

Blockson Chemical Co., Joliet, Ill.
General Chemical Div., Allied Chemical and Dye Corp., 40 Rector St., New York 6, N. Y.
E. I. Dupont DeNemours and Co., Inc., Wilmington, Del.
Aluminum Co. of America, Chemicals Div., 624 Gulf Bldg., Pittsburgh 19, Pa.

Conclusions to be Drawn

Some general conclusions can be drawn from our experience:

1. The writer can agree with Enslow[2] that there is no reason for waterworks managers to hesitate in their cooperation with, and support of, the health authorities in local fluoridation programs.
2. Fluoridation does not present any particularly new problems to the waterworks profession, but it does impose a clear obligation on the part of the operator to control application of the fluoride within closer limits than is usual with other chemicals. Technical control is essential and frequent analyses together with adequate records are required, if liability due to negligence is to be avoided.
3. Optimum dosages for maximum harmless effect, as related to climatological conditions, has not been determined. Additional controlled studies on an experimental basis will be required. Similarly, it is suggested that fluoridation may ultimately be refined on a seasonal basis and related to water intake of the generation being protected. In any event it is believed that generally lower dosages of fluoride will be required in the South and Southwest than in Northern climates.
4. The chemical costs are not high when computed on an annual per capita cost for the treatment. Sodium Silico-fluoride offers the prospect of reducing these costs very materially. Lower overall dosages (below 1 ppm) in the South will also lower costs.
5. Finally it is firmly believed that any municipality considering fluoridation should follow insofar as possible the recommendations of the American Water Works Association.

Addenda

Ed. Note.—Since the delivery of this paper Author Phillips has advised that the considerable increase in quoted prices for the silico-fluoride will change his evaluation of the savings to be effected in the use of the silico-fluoride instead of sodium fluoride. At present price comparisons the reduction in cost will more nearly approximate 50% than the 60% to 70% anticipated on the basis of comparative prices at the time the article was prepared, November, 1950.

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"Bob" Simms Named Man of Year by Spartanburg

Kiwanis Club Picks 30 Yr. Water and Sewerage Supt.

Less than a year ago Spartanburg, S.C., honored its water works superintendent by naming the enlarged water purification plant "The Robert B. Simms Filtration Plant" in recognition of his 30 years of service to Spartanburg as superintendent of a constantly growing water system.

Recently the Spartanburg Kiwanis Club named "Bob" Simms as "Spartanburg's Citizen of the Year," and presented him with the citation scroll at a special dinner attended by 300 members and guests desirous of doing honor to their water works superintendent.

The citation emphasizes the fact that the award covers not one year but the thirty years of accumulated service to the community, during which "Bob" Simms "has so impressed us with confidence, love and admiration as to endear himself to every citizen of the city and the county of Spartanburg."

In view of the recognition accorded "Bob" Simms by his City and his brother Kiwanians it was doubly fitting that the Southeast Section of A.W.W.A. last fall voted him the George W. Fuller Award of 1950 for outstanding achievement in the field of water supply and public relations.

Postal-Card Billing to Save $12,000 per Year

Milwaukee, by going to billing by penny postal-cards for water service, estimates that the saving by this change in method of billing will save the Water Department $12,000 a year, according to E. F. Taughe, Sup't. of Water. Heretofore, the quarterly water bills have been delivered to the 105,000 non-commercial accounts by meter readers.

"Limpid Liquid"

Hough "Payloader"—one of Three of These Useful Loaders

Operating Costs of Construction Equipment*

by SHERMAN L. ROGERS, *Sup't. of Distribution, Metropolitan District Water Bureau, Hartford, Connecticut*

UNTIL after World War II, The Water Bureau of the Metropolitan District of Hartford, Conn., depended almost entirely on rented construction equipment, aside from compressors and trucks, to do its construction and maintenance work. The water system of this district consists of about 700 miles of water mains, 44,000 services and about 4,450 hydrants. In 1948 and 1949, about 18 miles of main were laid and about 2,100 services were installed with our own forces. In the first eight months of 1950, as much work was performed as was done during all of 1949.

Hiring heavy equipment seemed reasonable until the rental bills began to assume such large proportions that in one year nearly $15,000.00 was paid out for rent of a ¾-cu. yd. backhoe and operator. At that time it appeared that it would pay The Water Bureau to buy one or more shovels but it was difficult to determine just what the operative costs would be and how far we should go in making these purchases.

Therefore, the attempt has been made to keep fairly accurate cost records, as various items have been purchased, to show whether or not there was any particular advantage in ownership and this paper reflects the result of this experience.

First Machine Purchased

Having rented nearly all kinds of backhoes in all kinds of condition, it was decided to buy first a ½-cu. yd. backhoe and crane on rubber. This machine, made by the General Excavator Co., has a four wheel drive, plenty of road clearance and can move over the road at about 18 mph. While it is possible for this machine to become mired in deep mud, it has been taken through some very bad going.

Soon after this machine was put to work on main pipe line construction, thought was given to some mechanical aid for service pipe excavation. Late in 1947 we believed we had the answer and bought a ⅜-cu. yd. Quickway backhoe mounted on a Ford six ton truck. This rig is highly mobile and takes up only a little more room in the street than an ordinary truck. In easy digging it is tops for this sort of work but we have so much hard digging in our district that we now believe that a slightly larger machine would be not only more efficient but cheaper to operate. This and other makes are made in the ⅝-cu. yd. size and when this machine is replaced, it will probably be with a heavier one.

Other New Equipment

To complete our line of excavators, the next purchase was a ¾-cu. yd. Unit backhoe on crawlers. Although this machine is a full heavy duty ¾-

*Presented before the New England Water Works Assn. and here published by permission of the Association.

"Unit" ½ Cu. Yd. Backhoe—A Good Economy Unit

yard machine weighing about 20 tons, we had it equipped with a ½-cu. yd. digging bucket. This gave us a heavy, powerful machine capable of producing plenty of trench in even the hardest digging and yet one which dug a trench only 31 inches wide instead of 39 inches wide which is about the usual width for a ¾-yd. bucket. This materially cuts down the costs of roadway replacements, and gasoline consumption is only about 15 gallons per day against about 30 gallons per day with the larger bucket.

We also have a 10-ton Link-Belt yard crane to handle pipe in the yard, where it was formerly handled by an overhead trolley system on an extensive wooden trestle. The cost of operating the crane is much less than the cost of maintaining the trestle and there is no comparison in the speed with which it loads and unloads pipe.

In addition, we also have two Hough payloaders used to backfill trenches, a smaller loader on a Case tractor to load sand or gravel from the yard stockpile, and a cold patch mixer. There is little or no saving connected with owning a cold patch mixer since it costs practically as much per ton to make cold patch as it does to buy it except that our trucks can take as little or as much as they need at one time and we can continue to make it during the winter months when all of the commercial plants are closed down. This feature alone is worth a great deal.

Operating Costs

Table I shows the total yearly cost of operating these machines. These figures represent all money spent for gasoline, oil, tires, and repairs, but overhead expenses and insurance are not included. The Quickway and the General were given complete overhauls last winter and the cost of this work was added to the annual costs to get the average annual costs to date.

It is generally recommended that machines of this type be depreciated by the straight method over a five-year period, and the various authorities agree that if machines like these are used 2,000 hours per year their useful life is likely to be about five years. Inasmuch as municipal organizations like ours seldom, if ever, operate 2,000 hours per year, a six-year depreciation period has been decided upon. Depreciation is a very important item since it is readily seen that on some machines depreciation is a larger figure than the actual costs of operation and maintenance. From the way in which we use it the Link-Belt crane will undoubtedly have a life of 10 or 12 years, but if the Quickway backhoe lasts out its allotted six years we will consider ourselves extremely fortunate.

Table II shows the cost per hour of operation. Most of these machines are equipped with hour meters which are electric clocks operating only when the ignition switch is on. By using this little device a surprisingly accurate account of the time that the machine actually runs can be obtained and the figures given are the average use per year under our conditions. The hourly time shown is not necessarily the actual time that the machine was on the job, but is the actual hours of operation with the motor running. This fact should be kept in mind when comparing our costs with the cost of rented machinery payment for rented machines is usually on the basis of how long it is on the job, regardless of whether the motor is running or not.

The difference between the figures in the last two columns represents the renter's insurance and overhead costs and profit and is also a portion of our savings due to ownership. Other savings are due to always having the machines available at short notice to

TABLE I - COST PER YEAR (less Operator)

Unit	1946	1947	1948	1949	Overhaul Cost	Average Cost Bare	Average Cost With Depreciation
Link Belt Crane - 10 Ton	$ 1699.1 *	$ 451.99	$ 216.51	$ 218.00	-	$ 222.79	$ 1090.09
General - ½ Yard	-	694.86 *	1220.26	1159.93	$ 1689.33	1476.91	4511.00
Unit - ¾ Yard	-	-	1982.63	1960.78	-	1991.70	5983.63
Quickway - ¾ Yd inch Truck	-	-	1741.06	1871.21	1609.00	2510.64	7693.69
Payloader # 196	-	606.63 *	1687.07	1962.66	-	1220.75	5218.41
Payloader # 200	-	-	-	773.89	-	773.89	1945.53

* = 6 months cost # = 9 months cost.

TABLE II - COST PER HOUR

Unit	Purchase Price	Hours in Use	Cost Bare	Cost Depreciation	Cost Operator	Cost Total #	Current Rental Charge
Link Belt Crane	$ 4007	400 E	$ 0.72	$ 1.86	$ 1.31	$ 3.89	$ 8.00
General	12204	1050	1.41	2.29	1.70	6.00	10.00
Unit	15248	1300	1.11	1.95	1.70	4.76	9.50
Quickway	7110	1200	1.09	0.98	1.50	4.58	8.00
Payloader	9450	1000 E	1.22	0.99	1.35	3.56	7.00
Payloader	7150	1000 E	0.77	1.19	1.35	3.31	7.00

E = Estimated
# = 20% should be added to figures in this column for insurance and overheads

TABLE III - COMPRESSOR UNIT COSTS

Unit	Approx First Cost	Yearly Compressor Hours in Use	Yearly Truck Mileage	Cost ① per Year	Cost per Hour Bare	Cost per Hour Depr.	Cost per Hour Total
Std Compressor and Service Truck *	$ 4400	1040	4760	$ 800.42	$ 0.77	$ 0.71	$ 1.48
P.T.O. Compressor and Service Truck **	4000	1040	4760	925.90	0.89	0.64	1.52
Std Compressor and Regular Truck #	3600	1100	4000	971.67	0.79	0.54	1.33
Std Compressor on Pneumatic Tires @	2200	800	-	510.17	0.39	0.46	0.85

* = Average of 5 units
** = " " 4 "
# = " " 2 "
① - Cost is divided about equally between truck and compressor.

help excavate for leaks during the night or on weekends. It is evident from these figures that it is probably better not to buy unless a piece of equipment can be used several hundred hours per year because depreciation goes on anyhow and idle equipment is a distinct liability.

Compressors

Most of our compressors are truck mounted with truck bodies especially built for carrying small tools, equipment and men. Some units have a regular 105-cu. ft. gasoline engine driven air compressor, and others have 105-cu. ft. air compressors driven through a power take-off by the Ford truck engine. There are other, older units, where a 105-cu. ft. gasoline engine driven compressor is mounted on a smaller truck with no provision for carrying men and also a few tow-about compressors on two rubber wheels.

Table III shows the average costs of operating each of the three types. A standard compressor on a special service truck is our favorite setup. These seem to give less trouble than the power take-off units and are cheaper to operate. We have four makes of compressors and each make presents a different problem when it is mounted on these service trucks. To save room on two makes we have taken off the gasoline tanks and air receivers. The compressor motors are then supplied from the truck tank and the air receivers are mounted on the side. At least one company has developed an especially compact unit for cross truck mounting.

Each of these compressors is equipped with a sump pump, a 60-lb. breaker, an 80-lb. breaker, two clay spades, and two backfill tampers. The average life of these tools is slightly over ten years. Usually they are rebuilt after about six years of use at about one-half the cost of a new tool, and then traded in when air consumption becomes excessive, usually in about ten years. Table IV shows the results of our experience with these pneumatic tools during 1949. Since many of these tools are comparatively new, operating costs over a period of years is likely to be somewhat higher than those shown. These tools are tested for air consumption about 10 times a year but these costs are not shown in the table since they are small and too hard to keep track of.

Costs vary considerably with the use to which machines are put and also with the care that they receive. A backhoe used only in sandy soil

"Quick-Way" ½ Cu. Yd. Backhoe—A Little on the Light Side.

TABLE IV

COST OF OPERATING PNEUMATIC TOOLS IN 1949

PER YEAR

	NUMBER	LABOR	MATERIAL	TOTAL	AVERAGE
CAULKING HAMMERS	5	$ 14.52	$ 28.19	$ 42.71	$ 8.54
CLAY DIGGERS	24	101.64	330.90	432.54	18.02
TAMPERS	29	92.38	203.20	295.58	10.19
PAVING BREAKERS	29	83.46	229.78	313.24	10.80
SUMP PUMPS	15	111.67	569.23	670.90	44.73
AIR WRENCHES	4	7.57	3.00	10.87	2.64

"General" ½ Cu. Yd. Backhoe—A Hard Worked Unit, and Our First

Fig. 5—Link-Belt Yard Crane.
A thoroughly useful piece of equipment in and out of the yard.

will last for years if it is kept greased and oiled, while a similar machine used for digging rock trenches will have a much shorter life. There is also a great difference in operators. One payloader operator may nurse his machine along and yet put out lots of work while another may bang and slam it around in rough spots and run up a large repair bill. During 1950 the three backhoes have been in almost constant use and in addition we have had a rented backhoe for several months and two others furnished to us by property developers. Observation has been that the unit cost of digging a foot of trench depends equally on the skill of the operator and the suitability and efficiency of the machine.

Additional Actions By A.W.W.A.'s Board

In our February issue we reported actions of the Directors of the Am. Water Works Association in so far as these actions pertained to the nomination of officers, bestowal of Honorary Memberships, making of awards, etc. Inasmuch as the Board was still in session at the time that the report was written, additional actions of the Board could not be reported because time for clearance of the report with A.W.W.A. headquarters was not available prior to our February issue deadline.

Although a number of matters of importance were taken up by the A.W.W.A. Board most of these are not subject to reporting at this juncture. Some of the other actions of principal interest are here reported.

A proposal to the Board that the Directors be given voting power in proportion to the membership in the Section represented by the particular Director, rather than the present and long standing process of one vote per Director, regardless of his status on the Board. The Board, after considerable discussion, voted to retain the longstanding method of voting on the senate plan of equal voting power of all Directors regardless of the numerical membership in the various Sections of A.W.W.A. On the other hand the Board saw no objection to the elected Directors, who met as the Nominating Committee of the Board, choosing its nominees for offices on the basis of weighted voting of Section Directors, the weight of each vote being based upon membership in the Section represented by the individual Director. In short, each new Nominating Committee (which means every year) can make its own decision on the method of voting in the selection of candidates for offices in the Association.

The Board approved as A.W.W.A. policy the establishment of awards or cups by Sections, which trophy may bear the name of either a *living* or a deceased member, so long as such award is made on a competitive level, such as in a contest of any sort (membership building being the best example), open to all members. Examples of this worthy type of stimulating award were cited as the long established trophy known as the Maffit Membership Cup of the N. C. Section, and the recently created Block Membership Cup of the Florida Section. A.W.W.A. policy, in regard to the establishment of any other form of Section awards named for a *living* member, is that the practice is injudicious and undesirable. The tenor of the Board seemed to be to encourage the establishment of some form of award or trophy for membership promotion in every Section.

The Board reviewed and re-affirmed the statement of "Association Policy re Fluoridation," as printed in the July 1949 issue of the Journal, and instructed the subsequently appointed Task Group on Fluoridation Practices to cooperate with a Committee to be named by the Conference of State Sanitary Engineers in the development of a procedural document which will meet the needs of the Public Health Official, as well as the needs of the water works operator. The latter was already under way by the A.W.W.A. Task Group, comprising some of the users of fluorides of longest experience.

The Board unanimously and enthusiastically, endorsed a proposal of the Publication Committee that there be produced a new "Water Works Manual" which will be developed with an aim to supply superintendents of the smaller and medium sized water works with a "Manual" of specific value to operators and superintendents in the smaller cities and towns. The task of planning and compiling such a Manual was assigned the Publication Committee, with an expression that the "Manual" be produced as early as possible to fill a genuine need.

The Board directed the establishment of two new special committees. The first committee will be expected to consider and evaluate all phases of research and studies related to water supply, to the end that study of problems of first importance be promoted and supported to the extent that surplus funds in the treasury of the Association permit.

A second committee will be named to develop a new and more appropriate design for the Seal of A.W.W.A., replacing the somewhat antiquated motif in the present seal which pictures a pumping station older than the Association pouring forth a black smoke-ribbon from its chimney. (And we'd hazard a guess that this station is also pumping unchlorinated river water.—Ed.)

Much more could be written concerning matters considered by the Board, contents of Committee progress report and the like, but we believe that what has been covered is of interest to the greatest number and going further would be to labor the report.

Laurel Filter Plant with Engine Room and Pump Room in Front

A Quarter-Century of Water Plant Operation

by FRANCIS GOSNELL, *Superintendent, Water Works, Laurel, Md.*

THE water system serving the Town of Laurel, Md., dates back to 1895 when the first pumps and distribution system were installed. No treatment was practiced at the time, with the result that non-potable water was distributed as was the custom of the time.

Early Plant

In 1912, an $80,000 bond issue was approved for sewer and water extensions and a filtration plant to provide water safe for human consumption. The construction was finished in 1914. The output at the plant in 1912 was approximately 40,000 gal. per day; in 1924 around 80,000 gal. per day; and now has increased to approximately 500,000 gal. per day.

For many years, the water works was operated without much thought or trouble to the superintendent. Few, if any, records were kept. In March, 1924 however, A. L. Gosnell took over the operation as superintendent; during the past twenty-five years, this plant has served the public well under his supervision. When he retired from full-time duty in 1945, the reins were turned over to the writer (his son) for continuation of the high operating standards set up over the years.

The duties of water superintendent in a small town are many and varied; including repair work, correspondence, co-ordination of all operations, public relations and maintenance of statistical records—a long step from the early days of pump operator. Complete records for the Laurel Water Works available over the past twenty-five years are ample proof that operation at this plant has kept abreast of the times, even if the equipment wore out.

Physical Plant

The water works as completed in 1914 and altered somewhat during the ensuing years consists of a reservoir, pump station and raw water line, settling basin, filters, clear well, high service pump and elevated storage tank.

The open reservoir one mile south of Laurel is of about four acres in area and has a maximum depth of six feet. It impounds water from a spring-fed creek named Bear Branch. The creek watershed area is 1.77 square miles; and the normal annual rainfall is approximately 42 inches, which provides an annual flow into the reservoir of well over a billion gallons. During plant operation at the maximum rate of 840,000 gpd., the spillage observed at the overflow weir would hardly fill a four inch pipe. The lake water is generally quite clear, but there are occasional turbidities of 100 ppm. caused by freshets. Algae troubles are present but no treatment is applied. Fishing and skating are permitted in season.

The raw water intake well, a brick structure, houses a 1 mgd. Worthington Monobloc Centrifugal Pump and a smaller capacity standby unit which was used regularly until three years ago when the new pump was installed. This old unit is still in good condition after many years of service; a standby motor is kept ready at the water plant should motor trouble arise. We have found by keeping the strainers on the foot valves of these pumps cleaned, more water per minute can be obtained from these pumps.

From the pump house at the lake, a 10-inch supply line carries the water from the reservoir to the filter plant a mile distant. The line leaves the lake, runs about 100 yards to the Washington-Baltimore Boulevard, where it follows the Boulevard to the plant in Laurel. All along the way, the pipe line is directly beneath the road bed, making accessibility for repair almost impractical.

The raw water from the supply line is discharged at the plant to a 26-foot

View of Laurel Lake, Showing Spillway and Pumphouse

square settling tank with around-the-end flow through three sections. The settling basin with a capacity of only 60,000 gallons has become no more than a flocculating basin. In an effort to increase the efficiency of the settling basin, baffles with 2-inch round holes were installed several years ago; this revision did more harm than good since the velocity through the holes increased, breaking up the floc particles. Water from the so-called settling tank flows to the filters.

Filters

The two filters are each 8 ft. by 14 ft., rapid sand type with the usual underdrain system leading to the clearwell. They were designed to take 2 gpm. per sq. ft., making a total rated capacity of approximately 23,000 gal. per hr. By frequent filter washings and much shorter filter runs, this amount has been stepped up to nearly 34,000 gal. per hr. Palmer filter bed agitators were installed some years ago to facilitate washing and increase filter runs.

The clearwell measures 16 ft. by 24 ft., 7 ft deep, and holds less than 20,000 gallons or 45 minutes pumpage. This fact necessitates pumping continuously while the filters are in operation.

Water is delivered into the distribution system from the clearwell by a 500 gpm. De Laval multiple-stage centrifugal pump powered by an 80 hp. Atlas Imperial Diesel Engine. This engine has been in service 15 years and still gives a good account of itself. Fuel to operate this engine costs about thirty-five cents an hour or one cent per thousand gallons as compared to $1.20 an hour, the cost of electricity used by the standby wash pump which is so arranged that it can also pump water from the clearwell into the mains, aside from its normal purpose of filter washing. This wash pump is a single stage 500 gpm. Worthington Centrifugal pump operated by a 50 hp. electric motor.

Operation

Black alum and lime are used as coagulants and are delivered into the supply line to the coagulating basin about 60 feet before reaching the basin. Wallace & Tiernan dry feeders are used, which mix the chemicals with water; then it flows by gravity through 1-inch rubber hose line and pipe to the raw water supply main. Chemically hydrated lime is used in the lime feeder when it can be secured. There are times, however, when non-chemical lime has to be used; the clogging of the feeder, valves and discharge lines then becomes a major problem, due to the high percentage of sand in the agricultural lime.

As mentioned before, although a good floc is usually produced, settling of much of this floc and solids in the water is well nigh impossible, due to the poor design of the settling basin.

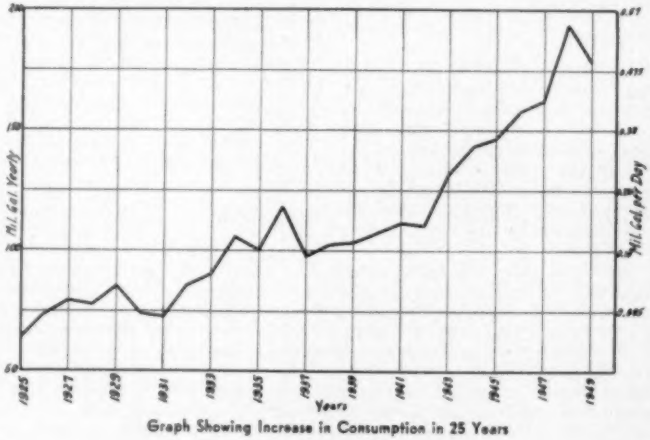
About 100 lb. of alum and 75 lb. of chemical lime are used daily. The alum has about 4 percent activated carbon mixed with it for purpose of taste and odor control.

After the water passes from the filters to the clearwell, liquid chlorine is added to produce a chlorine residual of about 2.0 ppm. For the half million gallon average daily pumpage, this amounts to about 8 lb. of chlorine daily. The high chlorine residual is being kept up as a test to try to help prove that a heavy chlorine dosage in a public water supply has some deterring effect on Polio outbreaks. Inasmuch as Laurel has escaped any cases in recent years, yet all of the adjacent areas have had more than their share, it seems worthwhile to carry the higher residual.

Chemically hydrated lime is added to the water in the clearwell to offset the acidity produced by the alum and to bring the pH of the water up above the neutral point. Sodium Hexametaphosphate is also used at this point in order to prevent rusty scum and deposit in bath tubs, kitchen sinks, and other porcelain fixtures. This treatment has been used for fourteen months, and satisfactory results have been obtained. In many homes, it is no longer necessary to scrub a rusty ring from the tub every time a bath is taken.

Filter Operation

Filter runs are very short because of the inadequate settling basin. In winter, a filter usually runs 15 hours; in summer, half that long between washings. The sand is low in the filter beds at this time, but 12 tons of new filter sand will be placed on the filters



Graph Showing Increase in Consumption in 25 Years

Table 1
FINANCIAL SUMMARY

Year	Water Rent Receipts	Operating Expenses	Surplus
1924	$ 8,227.22	$ 4,360.42	$ 3,866.79
1925	8,654.59	4,586.93	4,067.66
1926	7,353.67	3,897.45	3,456.22
1927	8,845.74	4,688.24	4,157.50
1928	8,797.79	4,662.83	*4,134.96
1929	8,797.79	4,662.83	*4,134.96
1930	6,322.49	3,034.80	3,288.00
1931	7,210.30	3,460.80	3,750.00
1932	9,313.77	4,470.60	4,843.17
1933	10,311.68	4,949.60	5,362.08
1934	10,005.44	5,205.83	4,802.17
1935	10,196.43	5,303.00	4,894.00
1936	15,485.46	7,333.00	8,152.00
1937	15,681.68	7,537.00	8,154.00
1938	15,651.07	7,512.48	7,965.00
1939	16,152.00	7,964.96	8,837.00
1940	17,458.96	9,340.30	9,078.66
1941	20,407.04	10,095.36	10,312.00
1942	19,378.92	9,310.88	10,077.04
1943	19,334.36	9,280.49	10,053.87
1944	21,371.73	10,113.30	11,258.43
1945	22,004.66	8,204.37	13,800.29
1946	21,472.70	7,783.26	13,689.44
1947	18,538.43	12,509.68	6,028.75
1948	23,963.66	13,746.95	10,216.71
1949	25,174.10	12,432.66	12,741.44
Total surplus, 25 year period			$203,322.14

* two year average

within the next couple of weeks. This should produce longer filter runs since the surface of the sand will be much closer to the rim of the wash troughs, thus permitting easier removal of the residue and mud while filters are being washed.

The plant is shut down at night when the pressure gauge indicates that the 200,000 gallon elevated tank is full; water for domestic use is drawn from this tank until morning. Operation is usually started at about 6 A.M. There is a pressure gauge in the writer's bathroom which gives ample warning if it becomes necessary to start the plant earlier than the usual time.

Starting the plant is not a simple matter. Many things can happen to foul one up but a delay of a couple of hours in getting the plant started just must not happen. Fortunately, for a quarter of a century, the mains have never been empty.

Increased Water Requirements

As has been pointed out previously, the water demand has increased from 40,000 gallons per day in 1912 to 500,000 gallons per day at the present time. No records of consumption are available prior to 1924. The accompanying graph shows the water consumption over the past 25 years. It is interesting to note that after a steady increase in the early 20's, the consumption dropped off in 1930 and 1931 due, no doubt, to the depression and hard times, again picking up in 1932 and showing a constant increase until 1949. It should be pointed out that with an increase of over 300 percent, no additional treatment facilities have been provided. The increase, for the most part, has been gradual except for the past five years; here the increase is more pronounced due to increase in population and the addition of many more new homes to the system since the end of the war in 1945.

For many years the population of Laurel hovered around the 2300 mark, perhaps from 1920 until 1940. The increase in use of water during this period, however, rose steadily due to a changeover from the wells and pumps of the old days to modern municipal supply. By 1940, everyone who owned a home within the city limits was required to have city water connection and sewers. The increase in water consumption since 1940, therefore, can be seen to stem from new homes and services rather than from the changeover just mentioned.

Because the city is not metered except for approximately 100 business places, it has been very hard to determine the average daily per capita consumption; but taking different factors into consideration the average daily per capita consumption is estimated at about 85 gal.

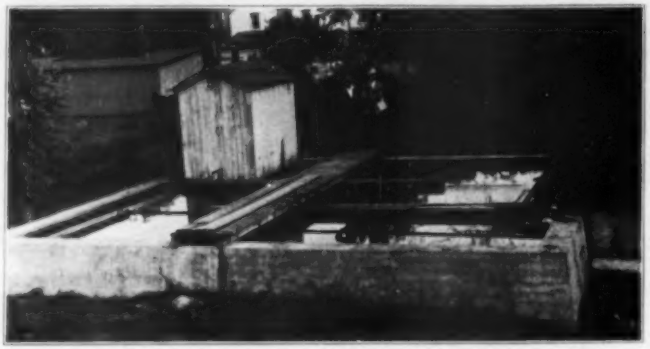
Cost of Operation

Of interest to many water works men is the cost of operating. Table 1 is a financial summary of cost data available. It is interesting to note that with increased production, the surplus continues to be about equal to the actual operating costs. Calculations of operating costs for 1949 are shown in Table 2.

A very close check has been kept on the cost of operation. All supplies, chemicals, labor, maintenance and miscellaneous items are recorded in a daily operating log. Nothing is left out. If a laborer from the street or sewer maintenance crew is borrowed for even an hour, his time is charged to the water plant expense account. At the end of the year, the City Treasurer's book is checked, item by item, against those charges listed by the water plant. When this tabulation is cleared up, we have a rather accurate account of the cost to operate the plant. Telephone and insurance are included as well as heat, light, power and everything that has any bearing or connection on the processing and pumping of the water. When the water reaches the distribution system, the expense of any repairs and maintenance is placed in a separate account.

Table 2
LAUREL WATER PLANT
COST OF OPERATION FOR 1919

1. Engineers' salaries			$ 4,775.00
2. Chemicals			
Alum	$ 596.90		
Sod. Phosph. & Chl. Lime	199.25		
Hyd. Lime	130.55		
Liq. Chlorine	228.44		1,155.14
3. Telephone	93.56		
Insurance	71.00		164.56
4. Electric current, repairs to motors, lights, etc.			
Gas & Electric Co.			3,180.79
5. Operation & Maintenance of Diesel eng.			
Gulf Oil Corp.	262.51		
Fuel oil	2,198.97		
Fleck Eng. Co.	250.27		
Atlas Eng. Co.	182.95		
W. Kaiser	5.10		
Laurel Motor Co.	56.09		
Laurel Automotive	4.20		2,960.09
6. Miscellaneous supplies:			
Coal	59.25		
Lumber	3.76		
Towels	21.85		
Transportation charges:			
Hopwood	20.28		
Baltimore & Ohio R.R.	1.00		
Davidson Transfer	1.75		
Miscellaneous:			
Laurel Hardware Co.	32.21		
A. S. C. E.	2.00		
Water Works School Expenses	9.70		
Boots (Beall's Dept. Store)	9.50		
Misc. (Dr. W. H. Donaldson)	1.39		
Fire Hose (C. Tharve)	12.00		
Leather for Valve (M. Kroop)	2.50		
Magazine Subscription	4.00		148.98
7. Miscellaneous Labor & help			48.10
City Plumber & Helpers			
TOTAL COST OF OPERATION			$12,432.66
RECEIPTS		$25,174.10	
EXPENSES		12,432.66	
SURPLUS		$12,741.44	



Coagulating Basin Looking from Roof of Street Maintenance Dept.
(Standing on the walkway is the author (left) and J. C. Smith, San. Engr. Washington Aqueduct System.)

Operating Problems

As a rule, the turbidity seldom rises above 150 ppm. after a storm or heavy rain. If it should go higher, it would not be possible to treat the water properly. The detention period in the settling basin is far too short to treat the water except under more or less normal conditions. There is usually a lapse of from 12 to 24 hours, however, after a storm before its effect is shown at the plant. It takes a little time for the highly turbid water to mix with that of the lake, thus giving time to prepare for it. The alum and lime feeder lines, being no larger than one-inch, make it difficult to treat properly water with a turbidity of over 100 ppm.

There are many operating problems, some of which have already been mentioned. The most critical one involves the main source of electric current to the motors at the lake; this current is carried by high tension wires along the Washington-Baltimore Boulevard. Whenever there is an accident on this boulevard in which a car strikes an electric pole, the result is a blown-out fuse at the lake or the electric current is shut off. This means that the entire plant must be shut down until repairs have been made. This situation occurs about two or three times a year but so far it has been possible to resume operations before the City of Laurel was without water.

Another problem arises from lack of adequate overnight storage facilities. A 200,000 gallon elevated storage tank has been in use since 1927. It is usually pumped close to full at night; but by morning, (after the plant has been shutdown of from six to eight hours) most of the water has been used. This is especially true after a rain, when hundreds of water siphons are operating in basements of homes. Should a fire occur early in the morning there would hardly be enough water to fight it. This condition can not be remedied easily without considerable expense; since another storage tank of equal size would have to be purchased.

The many siphons mentioned above are another "headache". Only a few of them are listed at the Collector's office; these pay only twenty-five cents a month for the privilege of using as much water as they like. Those not registered are using thousands of gallons of water at the City's expense. This condition is known to the City Council; and steps are being taken to either eliminate the siphons or place each and every one on a metered basis.

There are two rapid sand filters, no spares. They are forced to run fifty per cent overload while the plant is in operation. When filter washing is necessary, and this happens several times daily, the pumping of water into the distribution system is usually interrupted; this is due to the smallness of the clearwell from which water is drawn by the wash pump for filter washing purposes. As stated previously, it is practically impossible to repair or recondition these filters since time can not be spared from the almost continuous operation of the plant to allow for but a few hours work on them.

The lake which is used as an impounding reservoir was first intended to hold in the neighborhood of 25,000,000 gallons of water. Over the years, much mud and silt has deposited in this lake, reducing its capacity to approximately 5,000,000 gallons. Algae and other living matter find this lake an ideal haven for thriving. Sudden changes in temperature cause an overturn in the water; this results in large volumes of algae and other troublesome matter being drawn into the intake pipe at the pump house which is located at the lowest level of the lake. The net result is that the filter plant receives the worst that is in the lake, and the clarified water goes over the spillway at the dam. It is expected that steps will soon be taken to remedy this bad condition by raising the location of the intake pipe.

There is a marked difference in the quality of water received in the winter from that of the summer months. In winter, the turbidity drops to about 35 ppm. and causes little operational difficulties except when sludge flushes across the lake bottom to our intake pipe. When this occurs, the filter runs shorten to about two or three hours each.

In the summertime, everything in the lake comes to life; algae and plant growth thrives. This usually does not present too big a problem, since twice as much fresh clear water is entering the lake daily as the amount being used.

A few months ago, several of the upper baffle boards in the settling basin were removed to see if better settling results could be secured. The main objection to the baffles as they were was the fact that the only means of passage of water from one section of the basin (there are three) to the next was through small two-inch holes. This caused more mixing and stirring than it did settling. Adequate mixing of lime and alum has already been accomplished by discharging them into the pipe line 60-feet before entering the settling basin. Floc begins to form in Chamber No. 1 in the basin. These solid baffles with only 2-inch holes were breaking up the floc. Better results have been obtained since the upper baffle boards have been removed. Water moves through the basin quietly now, and the floc has a better opportunity to settle.

Future Planning

Up to this writing, Laurel has had ample water for its needs. The supply is limited; but so far it has met all requirements. At the most, there has been no need to run the filter plant more than 16 or 18 hours a day. The source of supply has not been exceeded.

However, since 1945 the City of Laurel has mushroomed in growth and has increased in population from 3500 to nearly 7500 and is continuing to grow. Therefore, it is not expected that this little water plant with two small 250 gpm. sand filters can hold out against the onslaught. Steps have already been taken by the Mayor and City Council to conduct a water survey to insure an adequate and safe

water supply for the Town of Laurel. This survey is now in progress. At this time three possible plans are being proposed, one of which will be adopted by the City.

The first proposition constitutes the building of a 12-inch pipe line some two miles west to the Willis School Filter Plant which is owned and operated by the Washington Suburban Sanitary District with the thought in mind of buying water from this company.

Second, to build a new, modern filtration plant along the Patuxent River just within the northwest border of the town limits, using the water from the Patuxent River, of which there is an adequate supply.

Third, expand the present water plant further by building new filters, settling bains, installing new pumps and equipment so that it can meet the water demand. All water that this plant would be unable to supply would be purchased from the Willis School Plant. In any event, the City is aware of the crisis which might loom ahead.

Equipment Condition

The low lift pump now in use at the lake is only three years old; an 800 gpm. Worthington Monobloc Centrifugal, it is very dependable. The standby is some twenty years of age, but has been rebuilt and runs like new. The pump house has been well insulated against the winter cold; and it has been many years since pumps or pipes have frozen in this house. No attendant is on duty there, and no heat is provided.

200,000 Gallon Elevated Storage Tank
(The 135,000 stand pipe on the right is no longer used.)

The 80 hp. Diesel Engine is the main source of power for pumping water into the system. It is 15 years old and has been rebuilt several times. It is kept in good condition and furnishes dependable service. As an alternate to this diesel engine, the wash pump which has seen 15 years of service is used.

The Wallace & Tiernan Chlorinator was purchased in 1947 and is entirely adequate and satisfactory.

Acknowledgment

The author wishes to acknowledge the help and training afforded over the many years by his father as well as the assistance of R. W. Simpson of Gilbert Associates, Inc. in preparing this paper.

Arkansas 20th Conference

Scheduled for April 9-11

The twentieth Annual Arkansas Water & Sewage Conference is scheduled to be held this year at Hot Springs, Ark., on April 9 to 11 inclusive. This annual event is again sponsored by and held with the cooperation of the Departments of Civil and Chemical Engineering of the University of Arkansas, the Southwest Section of AWWA and the Ark. State Board of Health.

This is the third program of the Arkansas Water and Sewage Conference devoted to short school work.

Sessions will be devoted to management, distribution, metering, water sources and pumping, water purification and sewage. During the meeting, the sewage section will hold its annual meeting and will be addressed by Earnest Boyce, Head, Civil Engr. Dept., Univ. of Mich. and Vice President of the Fed. of Sewage and Industrial Wastes Assns. Secretary of the Conference is Harrison Hale, Prof. of Chem., University of Arkansas, Fayetteville, Ark.

3,000 Homes in Little Rock With Frozen Water Lines

A letter from L. A. Jackson, manager, Little Rock, Ark., Water Works tells of the coldest weather in 34 years, with the result that 3,000 experienced frozen water lines during the cold snap during the first week in February when the thermometer dropped to 5 degrees below zero. At one time the water department had 18 cars and crews out thawing service lines and assisting home owners in restoring water service.

With the beginning of the cold wave and for four days ads were inserted in the local newspaper warning Little Rock residents to prepare against possible frozen water lines by draining the house piping system or allow tiny streams of water to run to waste from each spigot. That this advice was followed by a number was evidenced by a jump in water use from 11,000,000 gals. daily to 19,000,000.

Amongst other things the Water Dept. ad warned in bold type—"Under no circumstances use fire or heat in the meter box. To do so will ruin the meter and will not restore service." This brings to mind an earlier year when Little Rock suffered heavily from damaged meters due to attempts at thawing.

That matters were pretty hectic in the Water Dept. for a time is evidenced by the telephone calls coming in at the rate of one a minute and the fact that 18 cars and crews were out on calls day and night during the emergency. The water mains proper suffered only slight damage, however.

Iron Removal and Water Softening*

by DANIEL J. SAUNDERS, *Vice President, The Permutit Co., New York City*

IRON and hardness are two of the most troublesome impurities in water supplies; iron because it stains everything with which it comes in contact and hardness because it wastes soap and forms scale. The tolerance for iron in municipal water supplies is usually stated as being 0.3 ppm., expressed as Fe. This concentration is only a very small fraction of the tolerance for hardness in municipal water supplies (i.e, usually 85 ppm. or 5 grains per gallon, expressed as $CaCO_3$.)

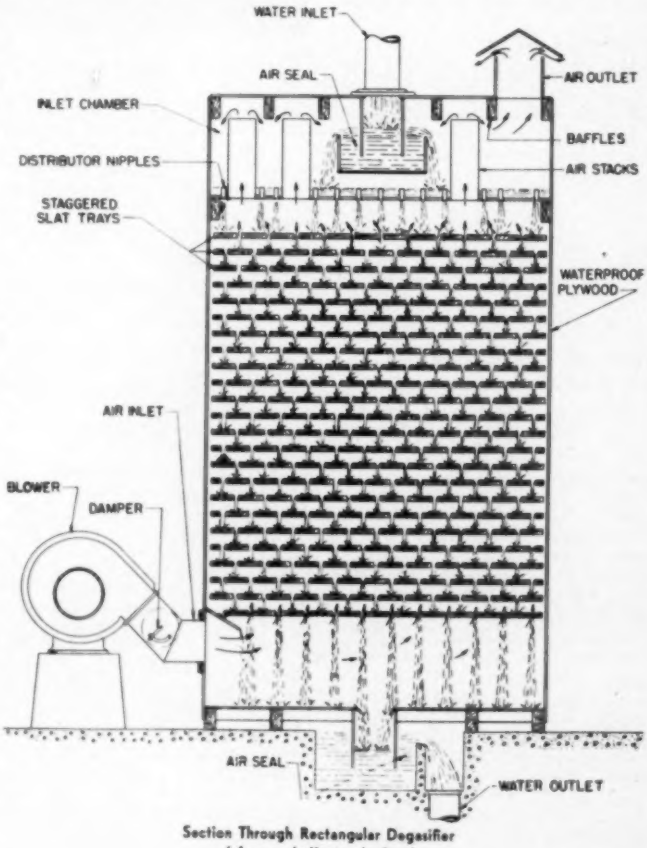
If the iron content exceeds this 0.3 ppm., staining becomes a serious problem, for then the bathtub, washbowl and other porcelain fixtures no longer present a spotlessly white gleaming appearance but instead, develop unsightly, rusty brown or even black stains which can usually be removed only by acid. (Parentheticallly, it might be remarked that the common practice of having a bottle of muriatic acid at hand for the removal of such stains is not to be recommended especially where children are concerned and oxalic acid is even worse for it is exceedingly poisonous.)

Iron also stains glassware, tiled floors and walls and other materials. As for laundering in an iron bearing water, this presents such an extremely serious staining problem that laundering in a high iron content water is practically an impossibility. Iron also unites with tannic acid to form ink so tea made with an iron bearing water may, depending on the iron content, develop off colors from a grayish to a diluted black muddy appearance. Of course, as everyone who has used such a water knows, if lemon is taken with the tea, it does bleach out the color. Coffee also, no matter what brand is used, becomes a rather muddy looking and unpalatable liquid. As for the plain drinking water if the iron content is 1 ppm. or over, an unpleasant metallic taste is very noticeable.

In the water supply distribution system, iron deposits tend to form, especially if the water has come in contact with air in a reservoir or storage tank. At times of heavy draft, these deposits are stirred up with the result that the water coming from household taps may temporarily become very muddy. Iron also favors the growth of various iron bacteria, popularly and collectively known as "iron crenothrix" and these growths have a tendency to break loose in clogging masses which frequently develop bad tastes and odors.

Methods of Iron Removal

In clear, deep well, iron bearing waters, the iron is present as soluble ferrous bicarbonate. Iron present in this form may be removed by (1) aeration, settling and filtration, (2)



Section Through Rectangular Degasifier
(Arrows indicate air flow)

*All illustrations are of Permutit Co. equipment.

by cation exchangers operating either on the sodium or hydrogen cycle, or (3) if present in amounts of 1 ppm. or less, by manganese zeolite filters.

Iron in an organic or colloidal form may be present in some surface waters, some shallow well waters and an occasional deep well water. Usually such waters have an appreciable content of organic matter and a high color. Organic iron can not be removed successfully by the methods used for the removal of ferrous bicarbonate but can be removed by coagulation with alum, settling and filtration.

Aeration, Settling and Filtration

In the first process mentioned above for iron removal, the water is first aerated, which serves both to oxidize the iron and to reduce the content of free carbon dioxide. Certain other oxidizing agents, such as chlorine, may be used, instead of air, but aeration is the process almost universally employed.

Aeration may be carried out in one of several types of open aerators, such as the step aerator, spray aerator, slat aerator, coke aerator, or occasionally, in open basins by blowing air through the water. Also, aeration may be carried out in closed pressure type aerators or aerating filters. In such cases calcite filters may be employed to lower the CO_2 content. Aeration may also be done in a closed type degasifier rectangular in cross-section with one side removable for cleaning.

The oxidizing action of the air converts the soluble ferrous bicarbonate to the practically insoluble ferric hydroxide. With certain waters, this oxidizing action is so slow that it is advisable to speed it up by raising the pH value to approximately 8.2.

As an illustration of the increased speed of oxidation of a ferrous compound at higher pH values, ferrous sulphate, commonly known by the misnomer "copperas," may well be used. Every chemist is familiar with the fact that a solution of ferrous sulphate, which has a low pH value, is fairly stable and that, when exposed to the air, oxidation proceeds at a very slow rate. If such a solution is treated with caustic soda, thus greatly increasing the pH value, oxidation, when air is present, proceeds very rapidly, and insoluble ferric hydroxide is formed.

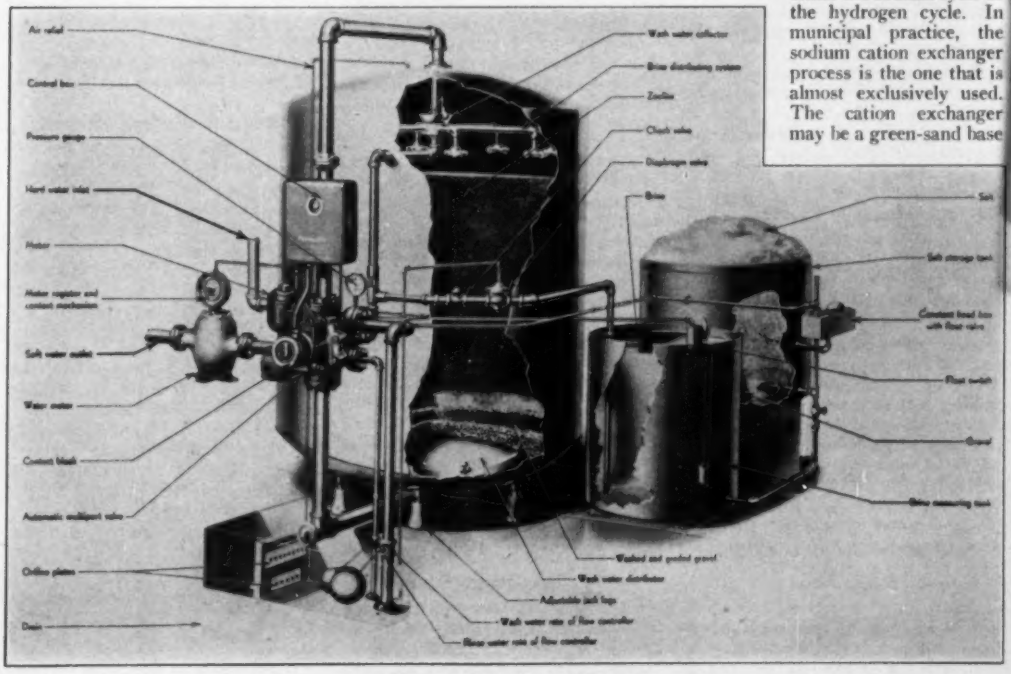
Similarly in waters of low pH value, containing ferrous bicarbonate, oxidation is slow although, of course, not so slow as with a solution of ferrous sulphate, which has a very much lower pH value. Therefore, aeration, by reducing the free carbon dioxide content, builds up the pH value and increases the speed of the oxidation. If, in addition, the pH value is increased by an alkali such as hydrated lime or caustic soda, the speed of the oxidation reaction is greatly increased.

The insoluble ferric hydrate produced by this process, may then be removed from the aerated water either by settling or by filtration, or more commonly, by settling followed by filtration. In the latter case, the settling is usually for a comparatively short period, some 15 to 30 minutes.

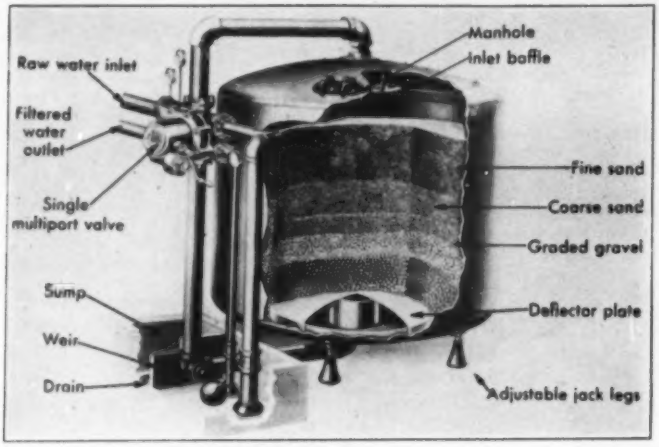
Filtration is accomplished by the use of sand or anthrafilt filters of either the gravity or pressure type. These are standard filters and as they are operated in the usual manner, no detailed description is necessary. In addition to the usual backwash, surface washers are frequently employed.

Cation Exchange

The removal of ferrous bicarbonate by cation exchange may be accomplished simultaneously with the removal of hardness by cation exchangers operating on either the sodium cycle or the hydrogen cycle. In municipal practice, the sodium cation exchanger process is the one that is almost exclusively used. The cation exchanger may be a green-sand base



Cut-away of Zeolite Water Softener



Pressure Filter

zeolite, or a carbonaceous or resin type.

When a clear, deep well water is to be softened and also freed from iron, the zeolite water softener may offer the simplest solution to the problem. With most of these waters, the removal is so complete that the iron content of the effluent will usually average 0.1 ppm. or less. In fact, in a few cases, zeolite water softeners have been installed primarily for iron removal, the water softening action being an incidental benefit.

On regeneration with salt, the iron, which has been taken up by the zeolite on the softening run, is liberated as ferrous chloride. This, together with the calcium and magnesium chlorides, is then thoroughly washed to the drain before returning the softener unit to service.

This process will answer for all normal water supplies; for waters of abnormally high iron content aeration, settling and filtration frequently precede zeolite water softeners.

Since the zeolite (or sodium cation exchanger process) yields a water of "zero" hardness, it is customary to by-pass enough hard water to give a mixed effluent with a hardness of about 5 grains per gallon. If the iron content of the raw water is too high to yield a mixed effluent with the desired iron tolerance, the by-pass water should be rendered iron free by separate treatment.

Manganese Zeolite Process

When the iron content is relatively low—1 ppm. or less—and softening is not required, the iron may be removed by means of manganese zeolite filters. The manganese zeolite is a special zeolite manufactured by converting a sodium zeolite to a manganese zeolite by treating it first with manganous chloride and then with potassium permanganate.

In order to remove iron by this process, the water is simply filtered through a bed of the manganese zeolite. This serves both to oxidize the iron to an insoluble form and to remove this product by the filtering action of the bed. These accumulations are removed by periodic backwashings and the oxidizing action is restored by occasional regenerations with potassium permanganate. In this process, only the iron is removed from the water as the manganese zeolite exerts no softening effect.

Cold Lime Soda Process

In the cold lime soda (or combination lime zeolite process), ferrous bicarbonate is easily removed with the hardness precipitates by introducing sufficient air into the water to oxidize the iron. If the carbon dioxide content of the raw water is rather low, all that is required is to drop the water, over a couple of steps or baffles, through an air space as it enters the treating tanks. If the water contains a relatively high content of carbon dioxide, then marked economies in the lime dosage may be effected by first passing the raw water through an aerator which may be mounted over the treating tank.

Organic or Colloidal Iron Removal

As previously stated, organic or colloidal iron is not satisfactorily removed by the foregoing processes. Instead it is necessary to coagulate, settle and filter the water. This is not always as simple as it sounds and it usually is necessary to run a series of jar tests to find the optimum conditions, that is, the dosages of coagulant and the pH requirements to secure a good coagulation and the formation of a satisfactory floc. The coagulant which is most widely employed is aluminum sulfate—filter alum—but chlorinateu copperas and ferric sulfate are also used.

Chlorination is sometimes of value in removing organic iron but in many cases it seems to have little or no effect. With waters of low mineral content, the use of clay or activated carbon is often of value in aiding floc formation and color removal.

Manganese Removal

Manganese, like iron, is an exceedingly troublesome impurity in water but fortunately is much rarer in occurrence. Like iron it may occur as the soluble bicarbonate or in colloidal or organic form. Also its methods of removal are similar, manganous bicarbonate being removed by (1) aeration, settling and filtration, (2) by cation exchangers operating either on the sodium or hydrogen cycle, or (3) by manganese zeolite filters. In removing it by aeration, settling and filtration, however, it is necessary to have a higher pH for its oxidation than is required for iron. In the organic or colloidal form, the method of removal is the same as with iron, that is, by coagulation, settling and filtration.

Municipal Water Softening

Hard waters, as everyone who has used them can well testify, are expensive nuisances. They waste tons of soaps; decrease the life of washable garments; making bathing, shampooing and shaving thoroughly unenjoyable; scale water heaters, boilers, hot water piping and cooking utensils; and increase costs for fuel, labor, repairs and replacements. While these trials and tribulations are recognized by all users, too few realize that it actually costs much less to soften a hard water than to continue using it. Surveys however have proven that, on the average, the costs for the materials used in softening a municipal water supply are only about one-third the cost of the soap wastage incurred in using the hard water.

There are three processes which are used in softening municipal water supplies. These are:

1. The zeolite (or sodium cation exchanger) process
2. The cold lime soda process

3. The combination lime-zeolite process

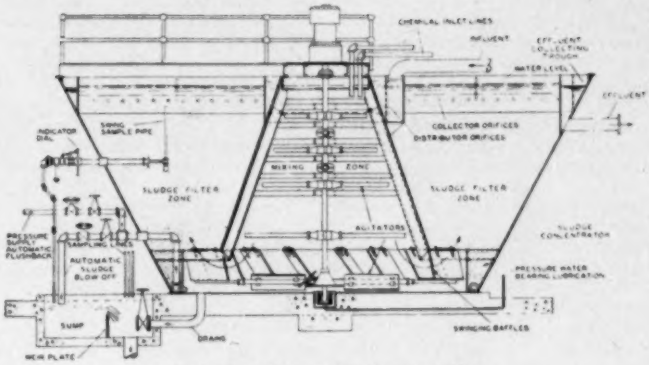
Zeolite (or Sodium Cation Exchanger)

In the zeolite (or sodium cation exchanger) process, the hard water is softened by merely flowing it through a bed composed of a granular sodium zeolite or an organic sodium cation exchanger. This removal of the hardness is so complete that the softened water is usually termed "zero water" meaning a water that is practically zero in hardness. After a definite amount of hardness has been abstracted, the bed is treated with a predetermined amount of common salt brine, which removes the hardness from the bed and restores it to its original sodium condition.

This restoration process is known as "regeneration" and consists of three steps: backwashing, salting and rinsing. The backwashing serves to loosen, cleanse and hydraulically regrade the bed. The salting serves to remove the hardness and simultaneously to restore the bed to its original sodium state. The rinsing serves to remove the excess salt and soluble by-products—calcium and magnesium chlorides—and wash them down the drain. These cycles of softening and regeneration may be repeated indefinitely as the wear and tear on the bed is very slight—usually under 3 per cent per year. Therefore only a slight addition of new material is required annually to keep the bed performing at its full rated capacity.

The softening plant may consist of a single softener unit or batteries of two or more units. In the latter case the units are usually of such a size that, when one unit is being regenerated, the other unit or units carry the full load. The softener units used in municipal practice may be either of the pressure type or the gravity type. In the pressure type, the bed is enclosed in a steel shell; in the gravity type, the bed is enclosed in a rectangular concrete shell. In both types, the bed is supported by several layers of graded gravel overlying an underdrain system. This serves to collect and pass the softened water to the service lines during the softening run; to distribute the backwash water during the backwashing operation; and to collect and pass to the drain the waste brine and rinse water during the salting and rinsing operations.

Zeolite (or sodium cation exchanger) water softeners are available in fully automatic, semi-automatic or manually operated designs. In the fully automatic pressure type softener, a motor operated valve is usually mounted on the front of the softener unit. In the gravity type softener, a motor operated pilot valve is used to regulate the hydraulically operated gate valves on the softener unit.



Line Drawing of Permutit Spaulding Precipitator

In either case, the principles of operation are the same. A water meter on the soft water outlet line is equipped with an electric contact head and an automatic resetting device. At the end of the softening run, a contact is made establishing an electric current which rotates the valve to the wash position. The length of the backwash period is governed by an electric time switch.

At the end of the backwash period, a current is again established which rotates the valve to the brine position. In this position, a predetermined volume of saturated salt brine is admitted to the softener, this volume being governed by an electric float switch. After the brine has been admitted the valve is rotated to the rinse position. The rinsing period is governed by an electric time switch and, at the end of this period, the valve is rotated to the soften position, which again places the softener unit in operation. In the meantime the resetting device on the meter has automatically reset it for the next softening run.

Semi-automatic operation is used principally on waters which may suddenly vary in composition. The semi-automatic units are similar to the fully automatic in operation with the single exception that the regeneration and return to service operations are initiated by the operator instead of by the meter. Manual operation is performed by the operator opening and closing the proper valves in sequence, timing the backwashing and rinsing operations and measuring the drawdown during the salting operation. The valves used may be either of the conventional type or the hydraulic type, the latter being operated from a control table.

In municipal practice, effluents having a hardness of 4 or 5 grains per gallon are usually desired. With the zeolite (or sodium cation exchanger) water softener, such effluents are obtained by softening a portion of the water to "zero" and then mixing with it whatever proportion of hard water is required to reach the desired quality of effluent. If the raw water contains appreciable amounts of iron, it is the usual practice to treat the raw water and remove its iron content before mixing it with the softener effluent. (See Iron Removal Section above.)

Cold Lime Soda Process

In the cold lime soda process, the hard water is treated with lime or lime and soda ash, added in such proportions and amounts as to precipitate the bulk of the hardness in the forms of calcium carbonate and magnesium hydroxide. The function of the lime is to remove free carbon dioxide; to change the calcium bicarbonate to the insoluble carbonate and when magnesium hardness reduction is required, to precipitate it as magnesium hydroxide. The function of the soda ash is to convert the chlorides or sulfates of lime and magnesia to the carbonates.

In waters which contain little or no sulfate (or non-carbonate) hardness, treatment with lime alone will be sufficient to reduce the hardness to the required tolerance. On the other hand if the non-carbonate hardness exceeds some 3 grains per gallon, the use of soda ash as well as lime is required to produce a 5 grain per gallon effluent. In either

case, the addition of a small amount of a coagulant—usually about 20 ppm. of aluminum sulfate—is desirable in order to form an easily settled floc.

Sludge Blanket Softeners

In the older or so-called "conventional" cold lime soda water softeners, treatment and settling was effected in large settling tanks or basins and the effluent was usually recarbonated before passing through the filters in order to prevent "growth" of the filter granules and "after deposits" in the distribution system. In the newer, sludge-blanket type of equipment, the treated water, by being brought in intimate contact with previously formed precipitates, is brought into chemical balance so that recarbonation is unnecessary unless a lowering of the pH value is required.

For the purpose of explaining this system, the "Permutit Spaulding Precipitator" will be described. The "Precipitator" is available in two basic types, the vertical and the horizontal and in sizes ranging from 10 mgd. per unit down to small units for carbonated beverage plants and other such uses, with capacities of only a few thousand gallons per day. Also it is possible to convert many of the older settling basins and tanks to the "Precipitator" type by remodeling their interiors and thus increasing their efficiencies, lowering their lime requirements and increasing their capacities.

The vertical "Precipitator" may be described as a cone, cut in half, the smaller portion, with the largest diameter downwardly disposed, being placed in the center of the larger portion, with the largest diameter upwardly disposed and with, of course, a space between the lower rim of the downcomer and the bottom of the tank. This downcomer is equipped with a centrally disposed, vertical agitator. The horizontal "Precipitator" differs from the vertical type in that the outer chamber is a rectangular concrete tank; that the inner chamber or downcomer is formed by sloping partitions and that two horizontal agitators are employed in the inner chamber, these being driven by a motor placed in a drive pit at one end of the Precipitator.

The principles of operation are the same in both types and may briefly be described as follows: The raw water and the chemicals enter at the top of the inner chamber and pass downwardly through it, the agitator serving to thoroughly mix the chemicals with the water and to keep the precipitates, formed by the reactions, in suspension. Emerging at the bottom of the inner chamber, the treated water flows upwardly through a suspended blanket of previously formed sludge. As the cross-sectional area of this outer chamber increases from bottom to top, the vertical velocity of the rising water constantly decreases until a level is reached beyond which it cannot lift the precipitates. In practice, there is a clear line of demarcation between the top of the sludge blanket and the clear effluent rising above it to the outlets.

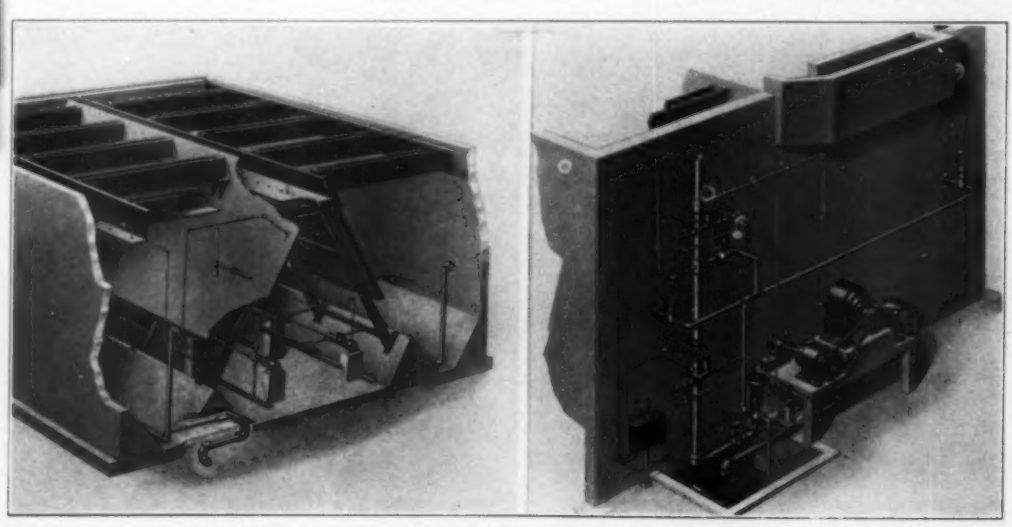
The intimate contact thus obtained between the precipitates and the water results in a complete utilization of the added lime; elimination of super-saturation and after-precipitates; and, due to the filtering action of the sludge blanket, the production of clearer effluents and longer filter runs.

The depth of the sludge blanket is kept between specified limits by bleeding off sludge, through sludge concentrators, at approximately the same rate at which new sludge is formed. These sludge concentrators are relatively small compartments in the bottom of the outer chamber through which there is no upward flow of water and in which, therefore, the requisite part of the sludge settles and concentrates to about 10 per cent solids.

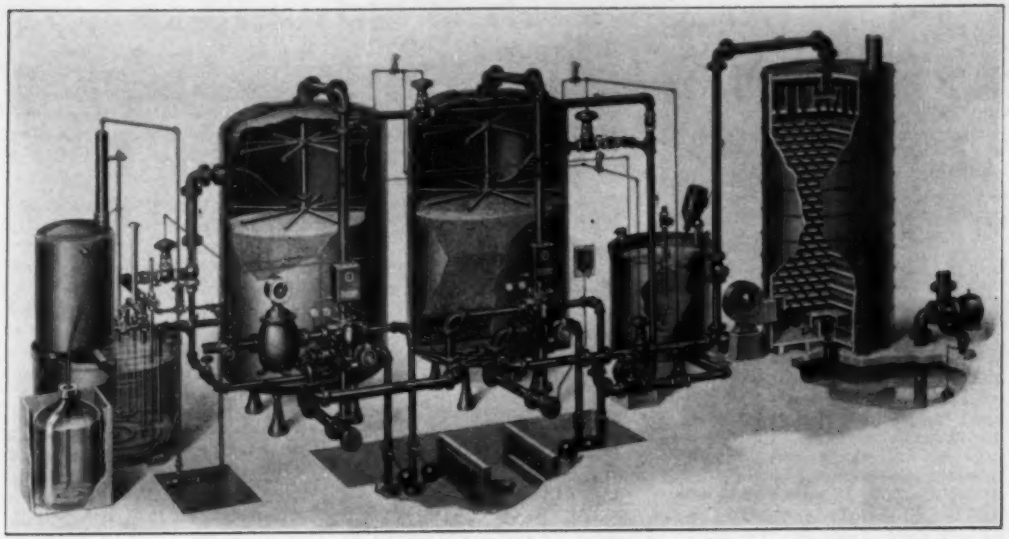
In municipal practice, the effluent from the "Precipitator" is filtered before passing to the clear well. The filters used are usually of the gravity type and therefore need no detailed description. In addition to their use in the cold lime soda water softening process, "Precipitators" may be used for the coagulation of turbid or colored waters.

Combination Lime Zeolite Process

In the combination lime zeolite process, the water is first treated



Cut-away View of Horizontal "Precipitator"
(Left—Interior; Right—Front Wall)



Automatic Demineralizing Plant with Degasifier

with lime to reduce the bicarbonate hardness. The filtered effluent is then passed through a zeolite (sodium cation exchanger) water softener to remove the noncarbonate hardness and residual carbonate hardness. With waters containing appreciable amounts of noncarbonate hardness, this process shows very economical operating costs as the cheapest method of removing bicarbonate hardness is with lime and the cheapest method of removing noncarbonate hardness is with zeolite.

Further advantages with this process are that it reduces the alkalinity and total solids content and that, where iron removal is concerned, the iron can be removed in the first stage of the process by introducing enough air to oxidize the iron to the ferric state. In using this process for municipal water softening, the usual 5 gpg. effluent may be obtained by mixing the requisite portion of the filtered lime treated water with the zeolite effluent.

The system used consists of a cold lime softener plus filters plus zeolite water softeners. If the pH value of the lime treated water is too high, a slight recarbonation will serve to reduce it. If the raw water is an iron or managanese bearing water, or, if the free carbon dioxide content is high, an aerator is employed ahead of the cold lime softener. This may consist of a coke tray or wood slat tray aerator; or, if only a slight aeration is needed, running the water over a few steps or baffles before it enters the cold lime softener will be sufficient; or, the air may be introduced by an air grid and compressor in a compartment ahead of the lime treatment.

Demineralization Process

While the hydrogen cation exchanger process, the ion exchange demineralizing process, find other uses than in the treatment of municipal water supplies, a brief description of them may be of interest. In the hydrogen cation exchanger process, the cation exchangers used are of the organic or non-siliceous types. These organic cation exchangers may, when regenerated with salt, be used in the same manner as the siliceous zeolites. Their most interesting use, however, is on the hydrogen cycle.

On the hydrogen cycle, the cation exchanger is regenerated with acid, usually sulfuric acid. The hydrogen thus introduced into the cation exchanger will exchange hydrogen for calcium, magnesium and sodium ions.

If a water containing nothing but the bicarbonates of these metals is passed through a hydrogen cation exchanger, the calcium, magnesium and sodium will be completely removed and nothing but free carbon dioxide will be left in the effluent. As the carbon dioxide is easily removed by aeration, such an aerated effluent would be practically the same as distilled water in composition.

However, if sulfates and chlorides are also present, these would appear in the effluent as the corresponding acids. These may be neutralized by the addition of soda ash or by mixing with the requisite quantity of water softened on the sodium cycle.

On the other hand, if complete removal of the sulfates and chlorides is required, then the effluent from the hydrogen cation exchanger is passed through an anion exchanger which completely removes the sulfuric and hydrochloric acids formed by the hydrogen cation exchanger. The carbon dioxide is then removed by aeration resulting in an effluent equivalent to a distilled water. As the cost of demineralization is only a very small fraction of the cost of distillation, this process is now coming into very extensive use wherever a water of such high quality is required.

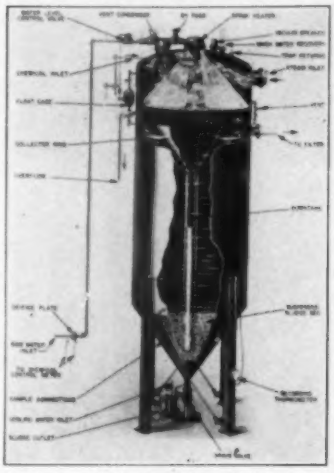
Hot Lime Soda Process

The hot lime soda process, too, may be of interest, although not used for municipal softening. It is confined almost exclusively to the softening of boiler feed waters as the process is carried out at the boiling point. The softener consists of a tall enclosed steel tank designed usually to withstand a pressure of about 10 psi. In the top of the softener is a spray heater, which heats and deaerates the water to less

than 0.3 ml. per liter of dissolved oxygen.

The lime and soda ash are fed to the hot water in the top of the softener where it reacts with the hardness producing a sludge. In the newer sludge blanket type design, the water flows through a downcomer in the center of the softener and then rises through a blanket of this suspended sludge. In the older types, the flow was downward to a short distance above the bottom where the treated water was drawn off through a cylindical uptake while the sludge settled to the bottom.

The sludge blanket type has rapidly come into popular favor particularly where the silica content, as well as the hardness, requires reduction or removal and it is built in a number of designs for handling makeup alone or both makeup and various amounts of condensate and for either a deaeration to 0.3 ml. per liter of dissolved oxygen or complete deaeration to less than 0.005 ml. per liter. In the latter case, the complete deaeration is effected by a clever use of the steam required for the primary heater; this steam being blown through the hot, softened and partially deaerated water in a deaerator compartment before being used in the primary heater.



Hot Process Softener—Sludge Blanket Design

The hot process softener will reduce the hardness to below 1.5 gpg. (25 ppm.) by the use of lime and soda ash alone and to as little as 1 or 2 ppm. when phosphate also is used. Also, by the use of dolomitic lime or activated magnesia, the silica content may economically be reduced to practically any desired figure.

The effluent from the hot process softener is filtered through pressure filters using a non-siliceous filter medium such as "Anthrafilt." These filters are periodically backwashed with hot softened water from the settling tank by means of a special backwash pump and the backwash water is returned to the top of the settling tank, thus recovering it. Since the process is carried out at temperatures around the boiling point, the softener tank and filters are usually lagged with insulating material to prevent heat losses. As previously stated, this process is almost exclusively limited to softening boiler feed waters, the few exceptions being where a very hot, softened process water is required.

GOING TO MIAMI?

All A.W.W.A. members have received advance information concerning the "Water Works Specials" scheduled for the Miami Convention from New York and Chicago for the convenience and pleasure of A.W.W.A. members and guests who like to travel together to Conventions.

More details concerning the planned optional tours which have been planned by the Convention Transportation Committee headed by Chairman E. A. Sigworth, are now available. Those who may be interested in travelling to the Miami Convention (April 29-May 4) with the water works group should promptly advise Mr. Sigworth; Suite 1333—230 Park Ave., New York, (17), N.Y. of such interest and request the details which we have not the time nor space to include in this issue.

The featured "Tour A" will take members from Chicago, New York, and way-points along the route, to Miami via New Orleans where a three day stop-over is planned. From New Orleans the route is to Miami via the famed Silver Spring of Florida and across Florida via sight-seeing busses to Daytona Beach, of racing-beach fame, and then on to Miami. This will be operated as an all expense tour, with everything planned.

For those who can not afford the time or expense of the alluring New Orleans—Silver Spring—Florida sightseeing tour other trains will take A.W.W.A. members and guests direct from Chicago, New York and way-stations to Miami. This direct run is known as "Tour B" with trains leaving Friday, Apr. 27th, from Chicago at 10 A.M.; New York at 10 P.M. and arriving in Miami Saturday evening from Chicago and Sunday morning from New York. In the case of "Tour B" only the costs of round trip rail and Pullman fares are covered in the accompanying listing of Tour Costs. Returning from Miami, only the direct rail runs are involved in what is being designated "Tour C."

For those desirous of making a post-convention visit to Cuba, "Tour D" is being offered with travel from Miami to Havana by plane or by boat, as desired. This tour constitutes an all-expense three day tour, with planned sight-seeing and entertainment in Havana. The cost of this tour will be $75.00 extra, if by plane, or $87.13 extra, if by boat.

Tour Costs

The following estimates of costs for the tours have been given by the Transportation Committee. Costs include round-trip tickets and Pullman accommodations, based on lower berth. In the case of Tour B and Tour C, no other expenses are included. Tour A is selected, costs are calculated to include all meals, hotel accommodations, sight-seeing trips, tips, etc.

Tours	From New York	From Chicago	From New Orleans
A-C	$320.00	$295.00	$210.00*
B-C	134.55	132.77	92.35
A-C-D	395.00	370.00	290.00*
B-C-D	210.00	210.00	175.00

*These fares are calculated to take in all features at New Orleans.

Don't Delay Reservations

In order that the Transportation Committee can make the necessary provisions for best accommodations, it is important that tentative if not positive reservations be requested as promptly as possible. The Committee has asked us to emphasize that it is necessary to make reservations a long time in advance for Pullman cars, hotel accommodations in New Orleans and Havana, buses for sight-seeing tours, guarantees for meals, etc. Therefore, address inquiries and requests for reservations, without delay, to—

E. A. Sigworth, Chm. Transportation,
Suite 1333—230 Park Avenue
New York 17, N. Y.

Text of Chlorine Order Controlling Distribution and Use

Supply for water and sewage treatment assured in quantity at least equal to 1950 use.

WASHINGTON, Jan. 23.—Following is the complete text of Order M-31, issued today by the National Production Authority, controlling the distribution and use of chlorine:

NPA Order M-31

PART 36—CHEMICALS

Subpart A—Chlorine

This order is found necessary and appropriate to promote the national defense and is issued pursuant to the authority of section 101 of the Defense Production Act of 1950. In the formulation of this order there has been consultation with industry representatives, and consideration has been given to their recommendations.

Sec.

36.1 What this subpart does.
36.2 Definitions.
36.3 Required shipment date.
36.4 Rejection of rated orders.
36.5 Limitations for acceptance of rated orders.
36.6 Orders for public health chlorine.
36.7 Sources of supply of public health chlorine.
36.8 Certification of orders.
36.9 Use of chlorine obtained upon certified order.
36.10 Delivery dates and rejection of orders for public health chlorine.
36.11 Supply of public health chlorine to distributors.
36.12 NPA assistance in placing rated orders.
36.13 Adjustments and exceptions.
36.14 Communications.
36.15 Records, audit, inspection and reports.
36.16 Violations.

Authority: 36.1 to 36.16 issued under Sec. 704, Pub. Law 774, 81st Cong. Interpret or apply Sec. 101, Pub. Law 774, 81st Cong., Sec. 101, E. O. 10161, Sept. 9, 1950, 15 F. R. 6105.

36.1 What This Subpart Does. This subpart applies particularly to producers and distributors of chlorine and provides rules for placing, accepting and scheduling rated orders for chlorine and orders for chlorine essential to public health. Its purposes are to provide equitable distribution of rated orders among all producers and distributors of chlorine, and to provide for filling public health needs for chlorine, in order to make possible maximum production of chlorine by reducing to a minimum disruption of normal distribution.

This subpart supplements Part 11 of this chapter (NPA Regulation 2) but only those provisions of Part 11 which are inconsistent with this order are superseded, and all other provisions of Part 11 continue to apply to the chlorine industry.

36.2 Definitions. As used in this subpart:

(A) "Person" means any individual, corporation, partnership, association or any other organized group of persons and includes agencies of the United States or any other government.

(B) "Chlorine" means the element chlorine, whether in gaseous or liquid form.

(C) "Producer" means any person who produces chlorine for sale.

(D) "Distributor" means any person who buys and receives from a producer chlorine and who resells or holds for resale such chlorine (including a repacker of chlorine).

(E) "Public health chlorine" means chlorine which is essential for purification of water for human consumption and use (exclusive of chlorine used for swimming pools) or for treatment of sewage, in order to protect the public health, welfare and safety.

(F) "Marketable production" means that portion of chlorine which remains for sale in the hands of a producer after deducting the amount of chlorine which he consumes in his other operations, and after deducting the chlorine which he sells and delivers by pipeline.

(G) "NPA" means National Production Authority in the Department of Commerce.

36.3 Required Shipment Date. A rated order for chlorine must specify shipment on a particular date or during a particular month which in no case may be earlier than required by the person placing the order. The producer must schedule the order for shipment within the requested month as close to the shipment date as is practicable considering the need for maximum production. The distributor must schedule the order for shipment within the requested month as close to the shipment date as is practicable.

36.4 Rejection of Rated Orders. Unless otherwise directed by NPA: A producer need not accept a rated order that is received less than 15 days prior to the first day of the month in which shipment is requested. A distributor need not accept a rated order that is received less than 20 days prior to the first day of the month in which shipment is requested.

36.5 Limitations for Acceptance of rated orders. Unless otherwise directed by NPA:

(A) No producer shall be required to accept rated orders for shipment in any month of a total tonnage of chlorine in excess of 10 per cent of his scheduled marketable production for such month for the type of container required for shipment.

(B) No producer or distributor shall be required to accept rated orders for an amount which is less than the minimum unit quantity sold by such producer or distributor in accordance with his standard practice.

(C) No distributor shall be required to accept rated orders for shipment in any month of a total tonnage of chlorine in excess of 10 per cent of the chlorine available to him during such month for the type of container required for shipment.

36.6 Orders for Public Health Chlorine. (A) In the interest of national defense, it is found necessary to provide for supplies of chlorine to all persons, whether public or private, engaged directly in the business or operation of purifying water for human consumption and use, or of treatment of sewage, where the use of chlorine is essential to public health.

(B) Every producer and distributor must accept and schedule for shipment each month, commencing March 1, 1951, orders for public health chlorine which may be placed with him by consumers thereof who were supplied with chlorine by such producer or distributor during the year 1950; provided, however, that the total amount of public health chlorine by weight required by this section to be delivered to each such consumer during 1951 need not exceed the total amount of chlorine delivered by the producer or distributor to such consumer during the year 1950. In any event, the amount of public health chlorine so required to be delivered in any month need not exceed 25 per cent of such total amount delivered during the year 1950.

(C) Deliveries under orders for public health chlorine are required to be scheduled and made in addition to deliveries required to be made under rated orders pursuant to Part 11 of this chapter (NPA Regulation 2) and to meet other

mandatory orders of NPA, but are not to be included among deliveries made under rated orders for the purpose of determining the obligations of producers and distributors under section 36.5 of this order.

36.7 Sources of Supply of Public Health Chlorine. Consumers of public health chlorine shall place all orders therefor for delivery in 1951 with the producers or distributors from which they received their supplies of chlorine during the year 1950 unless they prefer and are able without the assistance of this order to purchase their chlorine needs elsewhere.

36.8 Certification of Orders. Every order for public health chlorine pursuant to this order shall contain a certification thereon or on a separate paper attached thereto, as follows:

"Certified Under NPA Order M-31"

Every such certificate constitutes a representation to the seller and to NPA that the chlorine called for in such order is required and will be used exclusively for the purification of water for human consumption and use (other than for a swimming pool) or for treatment of sewage. Every such certificate shall be duly signed by the purchaser.

36.9 Use of Chlorine Obtained Upon Certified Order. All chlorine obtained under purchase orders certified as provided in section 36.8 of this order shall be used by the deliveree exclusively for the purpose or purposes set forth in that section.

36.10 Delivery Dates and Rejection of Orders for Public Health Chlorine. Unless otherwise directed by NPA: An order for public health chlorine must specify shipment on a date or during a particular month which in no case may be earlier than required by the person placing the order. A producer need not accept an order for public health chlorine that is received less than 15 days prior to the first day of the month in which shipment is requested. A distributor need not accept an order for public health chlorine that is received less than 20 days prior to the first day of the month in which shipment is requested.

36.11 Supply of Public Health Chlorine to Distributors. (A) In all instances where consumers of public health chlorine purchase their supplies of chlorine for 1951 from a distributor as provided in section 36.6 of this order, any producer who supplied any such distributor with chlorine during 1950 must accept and schedule for shipment each month during 1951, commencing March 1, 1951, orders of the distributor for chlorine in at least the quantity of public health chlorine which the distributor is required to deliver or has delivered to the consumer (his customer) unless that quantity is less than the smallest practicable delivery unit, in which event the quantity shall be such unit: Provided, however, that the total amount of chlorine required by this section to be delivered to the distributor need not exceed the total amount delivered to him by the producer in 1950. In any event, the amount of chlorine so required to be delivered to the distributor in any month need not exceed 25 per cent of such total amount delivered during the year 1950.

(B) Every order of the distributor referred to in this section shall contain a certification thereon or on a separate paper attached thereto as follows:

"Certified Under NPA Order M-31"

Every such certificate constitutes a representation to the seller and to NPA that the distributor delivered or will deliver the chlorine called for in such order of the distributor, to a consumer whose certificate in accordance with section 36.8 of this subpart has been or will be, prior to such delivery, received by the distributor. Every such certificate of the distributor shall be duly signed by the distributor.

(C) All orders of distributors pursuant to this section are subject to the requirements of subdivision (C) of section 36.6 and of section 36.10 of this order and for the purpose of said sections shall be deemed to be direct orders for public health chlorine.

36.12 NPA Assistance in Placing Rated Orders. Any person who is unable to place a rated order for chlorine due to the limitations imposed by Section 36.5 of this order or who is unable to place an order for chlorine as provided in Sections 36.6 or 36.11 of this order, should apply to NPA, Washington 25, D.C., Ref.: M-31, specifying the producers or distributors who refused to accept the order. NPA will arrange to assist him in locating sources of supply.

36.13 Adjustments and Exceptions. Any person affected by any provision of this subpart may file with NPA a request for adjustment or exception upon the ground that his business operation was commenced during or after the base period or that such provision otherwise works an undue or exceptional hardship upon him not suffered generally by others in the same trade or industry, or that its enforcement against him would not be in the interest of the national defense or in the public interest.

In considering requests for adjustment which claim that the public interest is prejudiced by the application of any provision of this order, consideration will be given to the requirements of public health and safety, civilian defense, and dislocation of labor and resulting unemployment that would impair the defense program. Each such request shall be in writing and shall set forth in all pertinent facts, the nature of the relief sought and the justification therefor.

36.14 Communications. All communications concerning this subpart shall be addressed to National Production Authority, Washington 25, D.C., Ref.: M-31.

36.15 Records, Audit, Inspection and Reports. (A) Each person participating in any transaction covered by this subpart shall retain in his possession for at least two years records of receipts, deliveries, inventories and use, in sufficient detail to permit an audit that determines for each transaction whether the provisions of this subpart have been met. This does not specify any particular accounting method and does not require alteration of the system of records customarily maintained, provided such records supply an adequate basis for audit. Records may be retained in the form of microfilm or other photographic copies instead of the originals.

(B) All records required by this subpart shall be made available at the usual place of business where maintained for inspection and audit by duly authorized representatives of NPA.

(C) Persons subject to this subpart shall make such records and submit such reports to NPA as it shall require, subject to the terms of the Federal Reports Act (Pub. Law 831, 77th Cong., U.S.C. 139-139F).

(Note: All reporting and record-keeping requirements of this order have been approved by the Bureau of Budget in accordance with the Federal Reports Act of 1942.)

36.16 Violations. Any person who wilfully violates any provision of this subpart or any other order or regulation of NPA or wilfully conceals a material fact or furnishes false information in the course of operations under this order is guilty of a crime and upon conviction may be punished by fine or imprisonment or both. In addition, administrative action may be taken against any such person to suspend his privilege of making or receiving further deliveries of materials or using facilities under priority or allocation control to deprive him of further priorities assistance.

This subpart shall take effect on Jan. 23, 1951.

National Production Authority,
W. H. Harrison, Administrator.

Controlling Tastes & Odors With Activated Carbon*

A Compilation of Proven Practices

by E. A. SIGWORTH, *Water Purification Div. Ind. Chem. Sales Div., West Virginia Pulp & Paper Co., New York City*

THE importance of palatability of water is being recognized more and more by the water works profession. Great strides have been made in removing color and turbidity and destroying harmful bacteria, so that today most public water supplies are clear and sparkling and safe from the health point of view. Great strides have also been made in improvement of palatability of water since the first application of activated carbon by George Spalding at the New Milford, N.J. plant of the Hackensack Water Co. in 1930. However, many instances still exist where unpalatable water is still being delivered to consumers, sometimes almost continuously and at other times for very short periods. Unfortunately, the consuming public will long remember unpalatable water even though it may be for only one day out of the year. Certainly those individuals desiring to develop good public relations must strive to deliver palatable water consistently.

It must also be borne in mind that the public of today is much more widely traveled than that of a generation ago. Thus consumers have an opportunity to taste water in other localities and can make comparisons which can sometimes react unfavorably to the local supply. Health officials realize that it is essential to deliver water which is perfectly safe from the bacteriological point of view. They also recognize that an unpalatable water can also constitute a health menace by driving consumers to more palatable but perhaps less safe supplies. Therefore, in an indirect way, it is recognized than an unpalatable water can be a possible contributing factor to the cause of illness within a community. With the various available methods for taste and odor control, greater emphasis would seem justified in attempting to produce palatable water.

*A complete revision and modernization of the article on "Taste and Odor Control" in the Ref. and Data issue of Wat. & Sew. Wks. in July 1947.

Causes of Odors

The three main causes of odors are: Algae growths within the water supply, decaying vegetation, and trade wastes. Of these algae are the most prevalent causes of odors as indicated by a survey conducted some years ago. Although there are many varieties of algae, the ones most likely to cause taste and odors fall within approximately 25 or 30 types. These algae, during their life cycle, give off compounds which result in characteristic odors in the water. In some cases, simply by smelling the water it is possible to decide the type of algae which may be causing the odor.

Decaying vegetation usually results in an odor which may be characterized as grassy, musty, swampy, or moldy. These odors result from decomposition of vegetable matter such as grass, under-water weeds, leaves, etc.

Although trade wastes may be the least frequent offender, they can also create the most difficult condition to correct. In other words, odor concentrations may reach extremely high proportions necessitating the entire ingenuity of the operator to reduce them to a palatable level.

Wherever possible, every effort should be made to prevent odors from reaching the water supply. Therefore, preventive measures should be adopted such as copper sulfate treatment for algae control, dredging or damming off shallow areas, and cooperation with plants on the water shed area in order to attempt to reduce trade waste pollution.

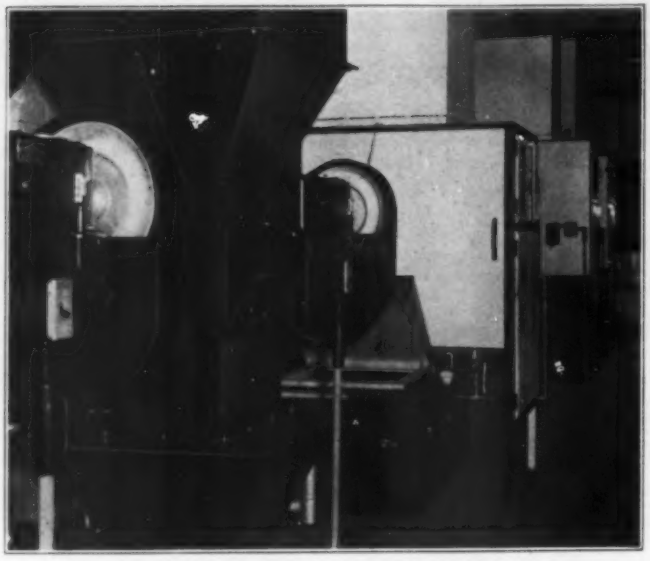
Evaluation of Odors

The development of the "Threshold Odor Test" has provided the industry with a satisfactory means for odor evaluation. This test involves diluting a sample of water with varying amounts of odor-free water until the point is reached where odors are just detectable and further dilutions show no detectable odor. By this method, odor concentrations can be assigned definite numbers directly proportional to odor concentration. For example, an odor number of 20 would be 10 times as strong as an odor number value of 2. Thus this test provides the water works operator with a means of determining when it is necessary to institute corrective methods for odor control.

It is also possible with this test to measure the relative efficiency of various treatment methods and chemicals, to determine when the water is palatable and when it is not, and to determine the best point of application for corrective treatment. It has been estimated that a threshold odor of 5 will normally constitute a palatable level for the average consumer. This value assumes an average observer and is based on odor evaluations being conducted on heated samples (60°C) which gives higher color values than those determined on cold samples. If the operator is super-sensitive to odors, the level of palatability might have to be increased, and vice versa.

Activated Carbon

Activated carbon, as most frequently used in water treatment, is a very fine black powder. Activated carbon acts by the phenomenon called *adsorption* which should not be confused with absorption. The concentration of certain specific substances at exposed surfaces is known as adsorption. On the other hand, the picking up of water by a sponge is known as absorption. If a container is filled with a dye solution and a sponge inserted in the solution and withdrawn, absorption takes place. The sponge takes up both water and dye without any change in concentration. In other words, it would be the same as pouring some of the dye solution out of the container. On the other hand, if a piece of clean cloth is dipped into the dye solution, there will be a greater proportion of the dye taken up on the cloth. If successive pieces of cloth are dipped into the dye solution, it will be possible to note a distinct lightening of the color of the dye solution. This phenomenon is known as adsorption.



Omega Dry Feeder for Activated Carbon at Richmond, Va.

If activated carbon is added to a dye solution it is frequently possible to obtain complete removal of the dye by adsorption. This phenomenon is explained by exposure of clean surfaces where impurities can concentrate and thus be removed from solution. This is one of the reasons that the carbon used in water purification is such a fine powder. Extremely small particles result in a greater degree of surface exposure, and the porous structure of activated carbon adds to this great amount of surface. Extremely clean surfaces may be considered as the really active patches on which maximum adsorption takes place. So great is the surface exposure obtainable with activated carbon that it has been calculated that one cubic inch of activated carbon can account for internal and external surface of approximately 10,000 square yards. It has also been estimated that one gram of activated carbon (about one normal heaping teaspoonful) will contain approximately 120 billion particles.

The fineness of the carbon particles, coupled with their porous character, gives another advantage in water treatment by permitting the carbon particles to disperse widely throughout the water and remain suspended for long periods of time. This dispersion and suspendability permits greater opportunity for odorous substances to come in contact with the active surfaces which then attract and hold the impurities on the carbon surface. As the carbon particles settle out or are removed by filtration, the odorous compounds are also removed.

It will thus be realized that adsorption of taste and odors with activated carbon actually removes the offender from the water. Therefore, it does not change the odor to some less offending compound nor does it mask objectionable odors.

Feeding Activated Carbon

Activated carbon is insoluble in water and, since it is rather difficult to wet, must be used as a slurry. It can be fed by dry-feed machines which proportion the carbon while in the dry condition, after which the carbon is wet in the solution box and subsequently applied as a carbon slurry. The predominant method of applying carbon is through dry-feed machines many of which are available on the market today.

Occasionally some difficulties are encountered with dry-feed machines so that the following suggestions are worthy of consideration. The feeding hopper should be so designed that powdered carbon will not bridge in the hopper thus preventing carbon from reaching the feeding mechanism. The capacity of the dry-feed machine should be more than ample to take care of the most severe odor condition likely to develop within the water treatment plant. The solution box should be designed so as to wet the carbon completely, and the water ejector should be of ample size and capacity to carry the carbon slurry away, even when the machine is operating at maximum capacity.

Some few plants still utilize solution methods of feeding carbon and there is a possibility that this method of carbon handling may increase in the future particularly where large quantities of carbon are involved. Several years ago the Metropolitan Water District of Los Angeles installed a tank for the purpose of storing activated carbon in slurry form. More recently the City of Chicago has done extensive work of a similar nature and has gone a step further.

In the case of the City of Chicago, arrangements were made whereby carbon would be received in bulk hopper cars from which the bulk carbon should be dumped directly into the slurry storage tanks. This method of carbon storage has many advantages such as reducing the dusting effect of carbon throughout the plant, reducing labor costs of handling bags of carbon, making available carbon in large concentrations ready to apply at a moment's notice, and assuring that the carbon particles are thoroughly wet and ready to go into immediate action when applied to the water supply. It is expected in the future that this method of handling carbon will receive wider acceptance but it is desirable to caution anyone interested that extreme care must be utilized in design of equipment, type of metals to be used, type of pumps, etc. (See "Progress in Carbon Slurry Handling at Chicago, Ill." by John R. Baylis—March 1950 issue, *Taste and Odor Control Journal.*)

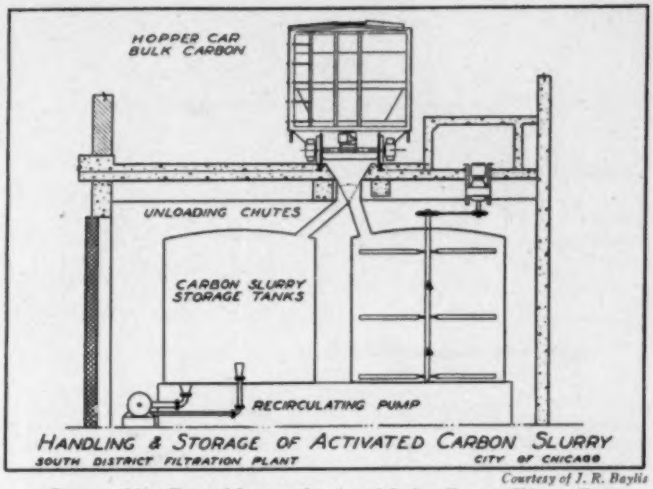
Points of Application

In a water treatment plant carbon should be applied at a point prior to filtration or, if no filters are available, prior to coagulation and settling. Thus, in the normal water treatment plant, carbon can be applied to the raw water, mixing basin, settling basin, or directly to the filters.

Where odors develop suddenly, they may get through the plant before being detected, and the carbon should be applied either on top of the filter or to the filter influent. In this manner, carbon is applied to that water which will first reach the consumer. This point of application is most frequently reported to give the greatest efficiency from the carbon for removal of tastes and odors. In many cases, surprisingly low carbon dosages are reported to give exceptionally good results in removing tastes and odors from water supplies by application to the filters. Where odors are usually at low concentration or appear at in-

frequent intervals, this point of application is usually recommended.

If high dosages of carbon are necessary to correct an odor condition, application of carbon to the filters may result in high loss of head, and possibly in the passage of carbon through the filter beds. Therefore, where carbon is used continuously, it is recommended that the point of application be moved so that it is applied at a point appreciably ahead of filtration. Also, where dosages in excess of 50 pounds per million gallons (6 ppm.) are necessary, carbon should not usually be applied to the filters. Under such circumstances, application is recommended to the mixing basin or to the raw water. In some cases, carbon has been applied part way through the settling basin but caution should be taken to insure that under such circumstances the carbon will have an opportunity to disperse rather uniformly throughout the entire body of water to be treated.



Courtesy of J. R. Baylis

Diagram of Handling and Storage of Activated Carbon Slurry at Chicago, Ill.

Use of other chemicals can also influence the best point for carbon application. For example, if lime or soda ash is utilized for pH adjustment, it may be desirable to apply carbon prior to these chemicals by as much as 15 to 20 minutes. This is particularly true if the pH of water is raised above the value of 8.5. In many cases alkaline substances are formed which may be less readily adsorbed by activated carbon. Phenol is a specific example, being less readily removed from water by carbon at high pH values.

It is never desirable to apply carbon and chlorine at the same point. Carbon has a tendency to adsorb chlorine just as it adsorbs odorous compounds. Thus some of the chlorine will be taken up by the carbon, thus reducing its potential for disinfecting the water. Also, the efficiency of carbon for adsorption of odorous compounds may be slightly decreased. Their points of application should be separated by at least 15 minutes and preferably more.

Just which chemical should precede the other will depend to some extent on existing conditions. If chlorine reacts with the odorous compound and makes it more difficult to remove by carbon, then carbon application should precede that of chlorine. Naturally the reverse is true if the chlorinated odorous compound is more readily adsorbed by carbon.

Based on experiences thus far, chlorine is more likely to make the odor compounds more difficult to remove with carbon. Therefore, as a general rule, it would be best that carbon application precede that of chlorine. If pre-chlorination is practiced and the chlorine is applied to the mixing basin, it is suggested that carbon be applied to the raw water as far in advance of reaching the mixing basin as possible (preferably 15 minutes or longer). By following this practice, carbon will have an opportunity to adsorb the odorous compounds before the chlorine has an opportunity to react. It may also be found that the carbon will adsorb other organic compounds which would normally constitute a chlorine demand. Thus, pre-treatment with carbon may possibly result in a reduction of the chlorine demand of the water.

Determining the Carbon Dosage

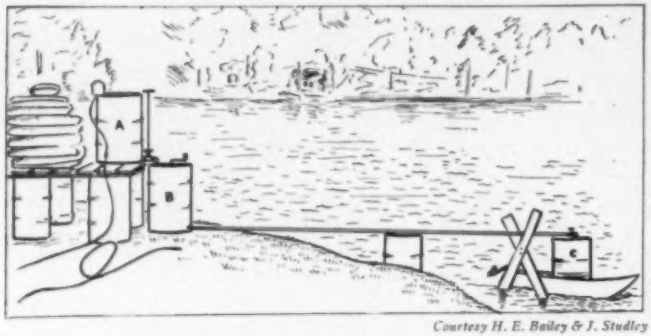
In many cases, particularly where suitable laboratory facilities are not available, the carbon dosage is determined by "hit-and-miss" methods in actual plant practice. This can frequently result in over or under dosage. More scientific methods are recommended.

In the laboratory, the use of the "Threshold Odor Test" is very successfully used in determining the carbon dosage. Naturally, it is necessary first, to know to what extent the odors must be removed in order that a palatable water can be delivered. For this purpose, a taste and odor panel is recommended consisting of at least four individuals. Samples of raw water should be chlorinated sufficiently to make the water safe for testing purposes. This water can then be filtered and diluted with varying amounts of odor-free water for tasting purposes. That sample having the least dilution of odor-free water and which is pronounced acceptable by all four tasters can usually be considered as the palatable limit. A threshold odor test can then be conducted on this sample of water and the threshold number will represent the value which must be reached in actual practice.

Having determined the palatable level, samples of water should then be treated with varying amounts of activated carbon. A sample should be collected at a point just prior to any carbon application. If carbon is not being used, a sample of raw water can be collected. To various samples, not to exceed four in number, should be added different dosages of activated carbon. For example, 2, 4, 8, and 16 ppm. If odor concentration is considered to be rather high, it would be desirable to use higher carbon dosages than suggested above.

After addition of the proper carbon dosage, each sample should be treated exactly the same as the existing treatment in the purification plant; this will include alum, lime, chlorine, etc. Individual contact times should parallel as closely as possible actual detention times in the plant. Then samples are finally filtered, preferably through glass wool as the filter medium. This glass wool and all receptacles should be thoroughly rinsed with odor-free water to assure that extraneous odors are not added to any of the samples.

Finally, these treated samples, and also a sample of the raw water, should be evaluated for threshold odor number in accordance with the procedure in "Standard Methods." Results obtained should be plotted on arithmetic graph paper and the curve drawn as accurately as possible to conform to the plotted points. From this curve it should be possible to determine the



Courtesy H. E. Bailey & J. Studley

Sketch Showing Arrangement for Carbon Treatment Plant at Open Reservoir

carbon dosage necessary to produce the threshold number which has previously been determined as acceptable for a palatable water.

In transposing these results to actual plant practice, it should be borne in mind that activated carbon accomplishes better results in plant practice than in small scale laboratory tests. Therefore, it is desirable that the dosage determined in the laboratory should be cut in half for the first plant test. Usually it will be found that half the laboratory dosage will give the desired results in plant practice. Some exceptions to this generalization have been encountered so that the final plant dosage may have to be increased or decreased to give optimum results. For example, if it is found that a laboratory dosage of 12 ppm. of activated carbon is necessary to reach the palatable level, only 6 ppm. carbon should be employed in the first plant scale test. Based on results obtained in the plant, it may be necessary to revise the carbon dosage to as low as 4 ppm. or perhaps as high as 8 or 10 ppm. Such relations, once developed between laboratory and plant results, can usually be utilized as a base in any subsequent tests.

Unfortunately, it is not possible to set any hard and fast rule as to the amount of carbon necessary, even though the threshold number of the raw water is known. For example, in some plants it has been found that one part per million of carbon is necessary for each threshold unit in order to accomplish palatability. Yet, in other parts of the country, this ratio may be one part of carbon for every three or four threshold odor units.

The type of odorous compound is also a contributing factor to this ratio. Therefore, if the type of odor changes suddenly, it is desirable to conduct another evaluation in order to determine the necessary carbon dosage. The reason for this is that some compounds may be easier or more difficult to adsorb by carbon. Also, it should be borne in mind that as odor intensities increase carbon dosages may have to be greatly increased. In other words, if the odor concentration suddenly doubles, it may be necessary to use three times as much carbon in order to remove the objectionable odors. In any case, laboratory tests can constitute a very valuable guide in determining the optimum carbon dosage for plant scale use, always bearing in mind the relation between laboratory and plant results.

In actual plant operation carbon dosages used will vary from as low as two pounds per million gallons to as high as one thousand pounds per million gallons. Extremely high dosages such as 500 pounds per million gallons or more are rather rare and, fortunately, are usually of only very short duration. Although costs of treatment during these short periods of time would seem to be enormous, the average cost over the year is usually found to be very reasonable. If the total carbon costs are calculated on a per capita per year basis, it will be found that the actual cost is very nominal.

Reservoir Application

Difficulties with unpalatable water unfortunately do not limit themselves to systems where water purification facilities exist. Unfiltered reservoir supplies are perhaps even more likely to have odor difficulties, particularly of the algae type, because the water must be clear in order to be suitable for delivery to the public. Since algae thrive more particularly in clear waters, impounded supplies must always face this problem.

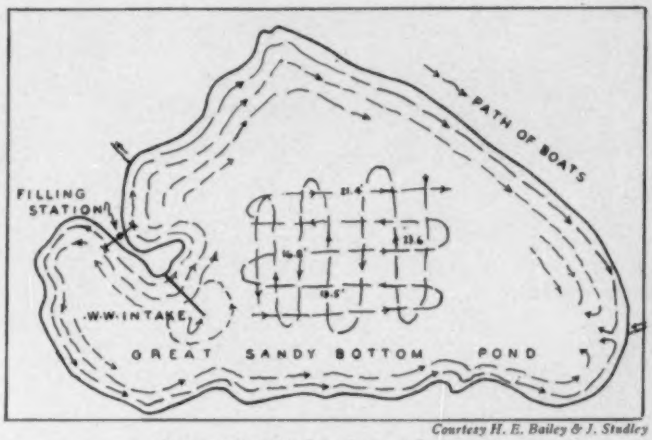
Since activated carbon is a fine black powder which will give a black turbidity to water, it is desirable that treatment be conducted so that little or no carbon reaches the distribution system. The general practice is to treat reservoirs with activated carbon so that no carbon is applied at any point near the reservoir intake. Thus the carbon particles have an opportunity to settle from the water and any small amount that might get into the distribution system would not be noticeable to the consumer. In some instances, carbon has been applied to reservoirs without regard to the proximity of the intake. Under these circumstances the dosage of carbon is usually kept at a minimum of say approximately 1 ppm. so that the small amount of carbon that would get through would not be sufficient to constitute consumer complaints. If the first treatment is insufficient to produce palatable water, further treatments can be made at weekly intervals until the difficulty is corrected and without any serious objections from the consumers.

In the actual application of carbon, the usual practice is to apply it in slurry form. This slurry form of carbon is applied to the reservoir on much the same principle as with copper sulfate. However, in the case of carbon, higher dosages should be applied in the deeper areas so that the carbon concentration in the water is distributed as uniformly as possible.

Preparing the carbon slurry can constitute a problem unless proper equipment is available. An excellent method was worked out by Howard E. Bailey and James B. Studley for applying carbon to a reservoir at Pembroke, Mass. (See "Activated Carbon Treatment of An Open Reservoir," *Water & Sewage Works*, p. 219, June, 1947.) In this particular case, arrangements were made to prepare a carbon slurry on the shore of the pond. This slurry was then piped to the water's edge where the boat could come in for charging. A drum in the boat was used to hold the carbon slurry from which it was discharged to the reservoir. Complete details are described in the above mentioned article.

Another procedure was utilized by Fred Luthy at Orange, New Jersey. A boat was equipped with a gasoline motor and pump, and a 50 gallon steel drum for the carbon slurry. Bags of carbon were loaded aboard the boat for wetting. The pump served to supply water to the drum where the carbon slurry was prepared, and the pump also served to force the carbon slurry under pressure through a hose for distribution to the surface of the reservoir. Complete details of this arrangement are included in an article entitled "Powdered Activated Carbon Application to Orange Reservoir"—September 1950 issue, *Taste and Odor Control Journal*.

Based on the small concentrations of carbon utilized thus far in reservoir applications with successful results, there seems reason to believe that this method of treatment constitutes a very efficient procedure. Generally speaking, dosages used are in the very low ranges normally used in water treatment plants. Yet, the production of a palatable water from a very severe odor condition has been the result very consistently. There is also the possibility that the carbon which settles out at the bottom of the reservoir can still accomplish beneficial results. This carbon will still have some reserve capacity for odor adsorption, and it may act toward stabilizing any decomposition odors which might normally develop at the reservoir bottom.



Courtesy H. E. Bailey & J. Studley

Course of Boats for Open Reservoir Treatment
(Great Sandy Bottom Pond, Rockland, Mass.—108 Acres, 300 mil. gal.)

Blackout of Algae

In addition to foods normally present in water, algae require sunlight and suitable temperatures for propagation. The fact that activated carbon gives a dark appearance to water was considered as a possibility for eliminating the sunlight which is considered one of the essentials for algae growths. The first application for this purpose is credited to the late William P. Bailey at Council Bluffs, Iowa. In the application of activated carbon for this purpose, the carbon is thoroughly wet and applied as a slurry to the entire surface of the body of water to be treated. For successful results, application is made once or twice each day during periods favorable to algae growths. Thus application is usually limited to the summer months and also only to days of prolonged sunlight. Naturally, during cloudy days, carbon application is not necessary.

It remained for Hartung and Lischer of the St. Louis County Water Department, St. Louis, Missouri, to determine the necessary carbon dosage to treat a particular water surface. Based on their studies, it was found that a dosage of approximately a quarter of a pound of carbon would successfully black out a water surface of 1,000 square feet. Thus it must be realized that the dosage necessary for carbon blackout is usually far below that necessary for accomplishing taste and odor control. However, if carbon is necessary for correction of odors, the amount used for algae blackout would automatically reduce the quantity of carbon necessary for eliminating odor conditions. Studies in the field have shown activated carbon to be the most universally successful answer to taste and odor problems. Some reported failures have been due to improper point of application or an attempt to accomplish results with too small a dosage. It is safe to state that almost all odors can be reduced to a palatable level with activated carbon if a sufficient quantity is used at the proper point of application.

Pointers Pertaining to Gasket Practice*

Although asbestos has been used for many years as a gasket material, sheet asbestos is still strictly up-to-date for many gasketing services. During the rubber scarcity period asbestos did itself proud in services deemed solvable only by rubber gaskets.

Rubber covered canvas gaskets are usually satisfactory in water and steam pipe joints up to 50 lb. pressure. Between 50 lb. and 160 lb. rubber covered wire gaskets 1/16 of an inch thick are often used. Corrugated steel gaskets give good service for superheated steam where pressures exceed 160 lb. Corrugated steel gaskets are not necessary in water lines of either low or high pressure.

By machining the flange faces in such a manner as to support or retain the gasket, blow-out dangers are minimized, greater unit pressure is exerted upon the gasket, and possibility of leakage is lessened. The objections to these flange faces is that they cost more, are more difficult to install, and are not easily taken apart. Retained gaskets are commonly used in high pressure liquid or gas lines.

In general, the thicker the gasket the more securely it can be clamped in the joint and the less the danger of leakage. This is particularly true if the gasket is elastic.

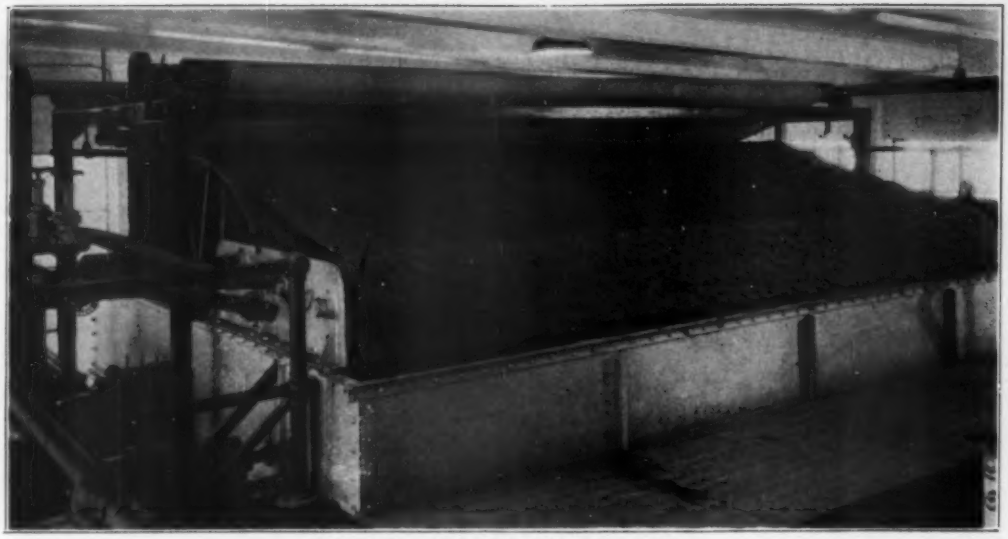
Ring gaskets are employed in the Van Stone joint and are highly satisfactory. They are comparatively small in area, consequently a high unit pressure is exerted upon them. The disadvantage of the full-faced gasket is the lower unit pressure and the consequent possibility of leakage.

Gaskets are made of many other materials, each material usually being best for certain particular purposes—aluminum, iron, monel metal, stainless steel, brass, bronze, cellulose, cardboard, cork, felt, fibre, lead, leather, mica, nickel, synthetic rubber, plastic materials, rawhide, silver, tin, wood, zinc, and numerous metallic alloys. In some rare instances gold and even platinum gaskets are used. As a result there is bound to be a solution for any gasketing problem that may arise, regardless of how difficult.

*Contributed by W. F. Schaphorst, M.E., Newark, N.J.

Nelson Withdraws from Baxter, Nelson and Woodman, Engrs.

Carlton Nelson has transferred his interest in the firm Baxter, Nelson and Woodman, Consulting Engineers, of Crystal Lake, Ill., to R. M. Baxter, senior partner. Henceforth the firm's name will be Baxter & Woodman.



Rockville Center, L.I., N.Y.—Wright Vaccum Filter

Sewage Treatment Plant Equipment

V—Vacuum Filtration of Sludge

(The Fifth Article of a Series)*

by FRANK L. FLOOD, *Partner, Metcalf & Eddy Engineers, Boston, Mass.*

VACUUM filters are used to dewater (1) raw primary sludge, (2) mixed raw primary and humus sludge from final settling tanks following trickling filters, (3) mixed raw primary sludge, and waste activated sludge, (4) waste activated sludge, and (5) sludge types (1), (2), and (3) above after digestion. The materials used in the construction of the vacuum filter should be designed for the particular sludge to be dewatered after chemical conditioning.

The Vacuum Filter

Mechanical dewatering by vacuum filtration of raw primary sludge has been employed at the Minneapolis-St. Paul sewage treatment plant since 1938. At this plant the sludge was conditioned prior to June, 1947 principally with ferric chloride and lime. The dosages of ferric chloride was about 1.1** per cent and of lime about 3.1** percent, both on the dry basis.

Following June, 1947, ferric sulfate was used in the place of ferric chloride when it was found impractical to obtain the latter chemical. During the early years of operation it became evident that the screens and woodwork were built up with excessive amounts of calcium carbonate which prevented the free passage of water into the interior piping system. It was learned that the periodic use of a hydrochloric acid bath containing an inhibitor resulted in the prevention of any major buildup of carbonate and at the same time extended the average life of filter cloth by 150 hr. to 200 hr.

In order to provide for washing of the filter cloth while the filter keeps on producing filter cake, the washwater pipe and spray nozzles were moved from their original location on the far side of the filter from the take-off plate, to a new location immediately behind and below the top edge of the take-off plate. The washing is done on the section of the drum between the take-off plate and the line of submergence in the filter pan. The spent wash water is collected in a trough which drains back to the settling tanks. Since November, 1947, the filters are washed at least once each hour for at least one revolution of the drum. Well water is used at a pressure of 50 to 70 psi.

The operators state that the new method of washing has reduced filtration costs, increased the filter area available and produced a more even feed to the incinerators.

The ferric chloride or ferric sulfate and lime process used for conditioning raw sludge at Minneapolis-St. Paul is also used for conditioning other raw and digested sludges. Wherever lime is used, conditions such as encountered at the Minneapolis-St. Paul plant may be anticipated and the materials of construction should be designed to take care of normal operation with alkaline sludge and for oc-

*Other articles in this series appeared in May, June, August and Oct. 1950

**5-yr. average to 1947

casional washing with inhibited hydrochloric acid.

Acid Conditions

When sludge is conditioned with ferric chloride alone, as may be the case with waste activated sludge and with digested elutriated sludge, the materials of construction should be such as to resist corrosion from ferric chloride solution under acid conditions. In smaller plants or otherwise where the filters operate only a few hours each day, corrosion of filters constructed without due regard to the ferric chloride condition sometimes does not show up for several years. Where the filters operate practically continuously, however, corrosion of the filters of conventional construction may become troublesome in a matter of months.

For acid conditions it appears advisable to specify acid-resisting bronze screens, staples, division strips, etc. The pipe and fittings between the drum compartments and the trunnion conduits should be highly resistant to acid conditions. Heavy-walled chemical hose, with the individual lines supported to prevent the formation of moisture traps and to prevent movement when the drum is revolved, has been advanced as one solution to the problem. "Saran" tubing, manufactured by the Dow Chemical Co., has been used but there has been some question of the permanency of the joints particularly inasmuch as there has been some plastic flow in pipelines made of "Saran." However, J. K. Adams[1] has reported that "Saran" piping in the vacuum filters at the Tenafly, New Jersey, sewage treatment plant has developed no leaks since the installation was made in 1944, the filtrate containing ferric chloride and having a pH of 4.0 to 5.0.

Tannery Waste Treatment, Rockford, Mich.—Oliver Filter
(Sludge of 6 per cent dry solids converted to cake of 30 per cent solids at yield of 2.84 lb. per sq. ft.)

For the filters at the main Toronto plant, pipe and fittings of "Uscolite" as made by U. S. Rubber Company have been accepted for filtrate piping where sludge is to be conditioned with ferric chloride.

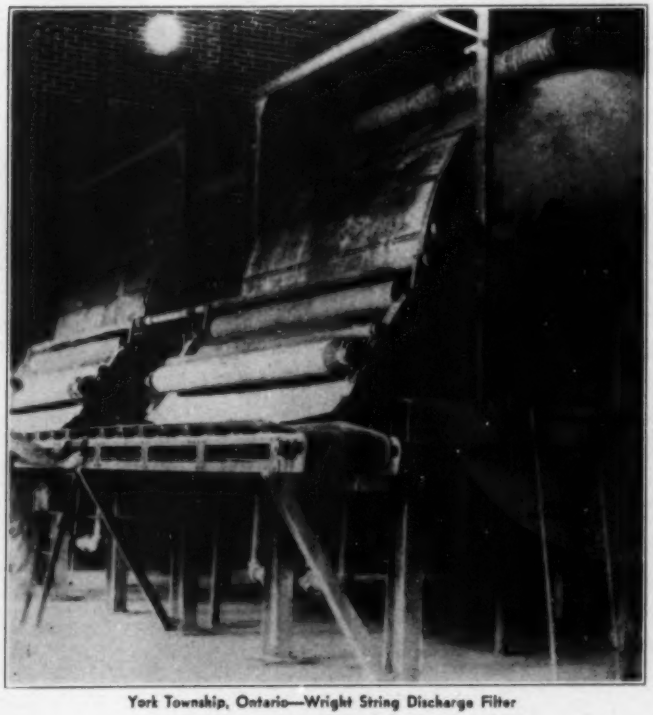
A newer model of vacuum filter has all vacuum piping connections outside the filter drum, thus greatly facilitating their repair or renewal.

Recent developments in the cord and coiled-spring-wound filters are promising. These filters do not require any filter cloth as the filter cake forms over the cord or spring coils and drops off as the filter media changes direction over an idler shaft off to one side of the filter drum.

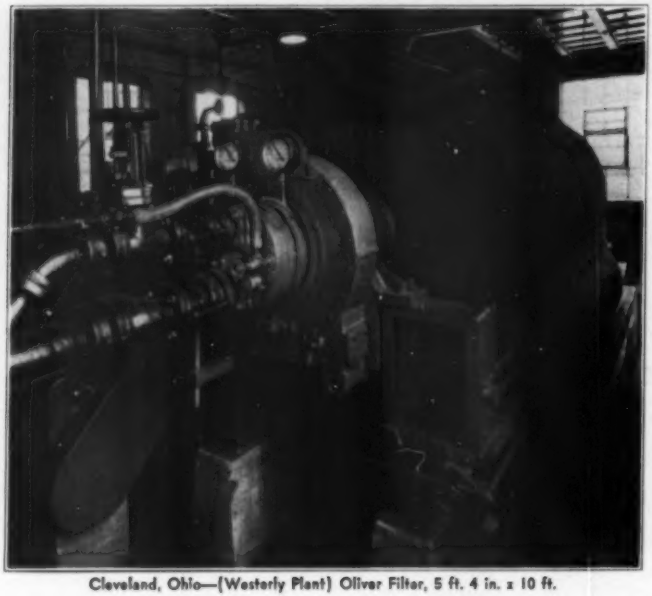
Sludge Agitators

Agitators are sometimes supported from the trunnion shaft of the filter. It has been asserted that this method of support produces frictional resistance to the rotation of the drum when the agitator swings in a reverse direction, results eventually in a jerky operation in large drums and causes undue wear on the vari-drive mechanism. For this reason, some engineers recommend that the agitators be supported on bearings below the trunnion shaft, or on the ends of the filter tank. The frequency of agitator oscillations depends upon the size of the tank and the characteristics of the sludge. The driving mechanism should be of variable speed to ac-

(1) Sewage Works Journal, April, 1950, p. 562.



York Township, Ontario—Wright String Discharge Filter



Cleveland, Ohio—(Westerly Plant) Oliver Filter, 5 ft. 4 in. x 10 ft.

commodate possible requirements.

Cake Take-off Plate

The sludge cake take-off plate should be provided with a replaceable cutting edge. For acid conditioned sludge this cutting edge has been specified to be of 18 per cent chromium and 8 per cent nickel-steel alloy, at least 3/16 in. thick.

Cake Slicers and Distributors

Unless some provision is made for cutting it up, the cake from the filter may drop off in large masses which create somewhat of a problem on the belt conveyors customarily provided for carrying the cake to a point of disposal. A reasonable design is to provide replaceable steel pins about ⅜ in. diameter threaded on one end for screwing into tapped holes on the cake apron. The pins should be spaced 8 to 12 inches on centers horizontally.

It is frequently helpful to provide a device for distributing the cake on the conveyor belt. This may be accomplished by mounting rotating cutting blades over the conveyor operated by a connection from a shaft on the conveyor. Experience at Hartford, Conn., and elsewhere has demonstrated that these cutters should revolve in the direction of travel of the belt. If they operate against the travel of the belt, there is a tendency for the cake to pile up in back of the cutters. The cutting blades are subject to considerable wear and should accordingly be designed to resist abrasion and for convenient replacement.

Auxiliary Equipment

Sludge Feed

In the larger installations, sludge is commonly fed to the conditioning tank ahead of the filter by bucket elevator operating from a sludge well. The elevator may advantageously be driven through variable-speed transmissions under electrical control, designed so that the sludge will be elevated at the rate of filtration and the sludge load in the conditioning tank and filter tank will be maintained within approved limits. Floats of hard rubber or glass with tape or chain of acid-resisting materials have been used in float chambers at the sludge conditioning tanks, with electrical transmitting devices designed to operate in connection with the electrical controls at the variable-speed transmissions on the bucket drives.

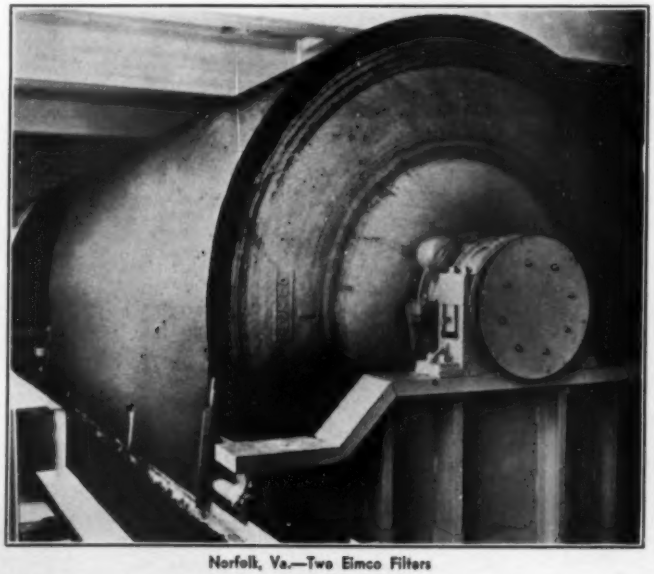
Ferric Chloride System

The handling, storage, making up of solution and the application of ferric chloride to sludge for conditioning ahead of vacuum filters, create multiple problems because of the extremely corrosive nature of the material.

Ferric chloride in liquid form is commonly stored in rubber-lined tanks. Where large storage capacity is required as at the Hyperion Plant in Los Angeles, the liquid ferric chloride may be stored in reinforced concrete tanks with a protective covering such as "Amer-coat."

Ferric chloride pumps have not always proven satisfactory. Other solution feed equipment is available, if desired, or it is sometimes possible to provide for raising the liquid ferric chloride by means of compressed air to small storage tanks at a high level from which the chemical can flow by gravity to the sludge conditioning tanks. Control of the rate of flow of the chemical can be accomplished by the use of ordinary pinchcocks.

Ferric chloride solution lines may



Norfolk, Va.—Two Eimco Filters

be of hard rubber, rubber-lined pipe, "Uscolite," "Saran," or other suitable acid-resisting materials depending upon the size of pipe and its situation. The valves should be of hard acid-resisting rubber. Plug valves may be of the "Durichlor-Nordstrom" lubricated type as made by the Duriron Company.

Automatic pH Control

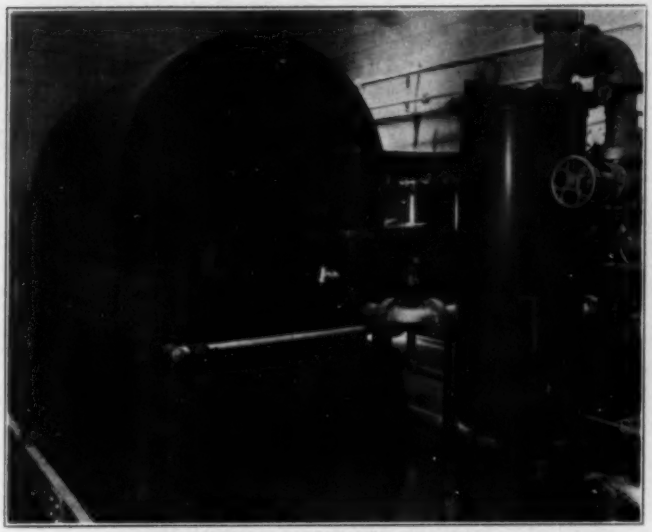
It is believed that automatic pH control of ferric chloride addition in connection with conditioning of digested elutriated sludges in the larger plants should result in economical use of ferric chloride under suitable conditions and proper regulation.

Mixers and Conditioning Tanks

It has been demonstrated that the design of mixing tanks for sludge and conditioning chemicals and the point and method of application of chemicals to the sludge in the mixing tank are of considerable importance for economical operation and for obtaining the optimum results at the filters. Elutriated sludge floc forms very rapidly after the addition of the chemical and the floc, once formed, should receive a minimum of disturbance and should be discharged to the filter tank as soon thereafter as is practical.

Vacuum Pumps

Wet vacuum pumps such as the Nash Hytor Rotary are used on the smaller filter installations. Vacuum pumps such as Ingersoll-Rand, or Worthington, single-stage, reciprocal dry vacuum pump, are used on the larger installations.

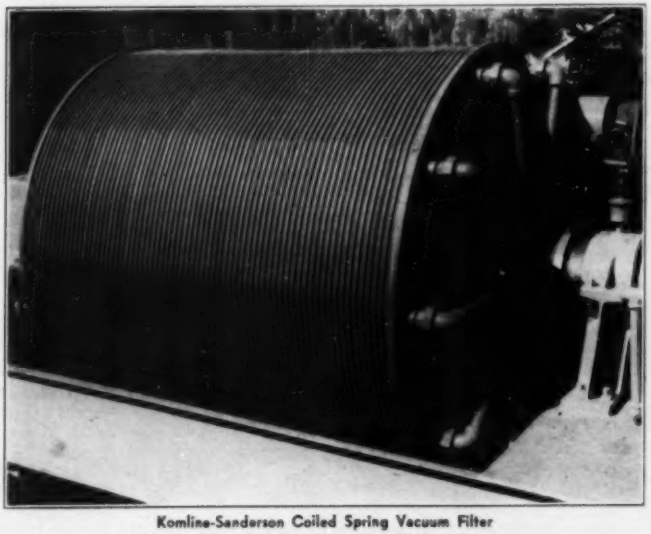


New Brunswick, N.J.—One of Twin FEinc. Filters
(6 ft. 6 in. dia.—7 ft. long. Dewatering settled and chemically precipitated sludge.—Note string discharge)

Each pump discharge should be provided with a suitable Burgess or Maxim silencer, of sufficient capacity to effectively silence the exhaust.

Vacuum receivers should be lined with rubber or coated with fibrated asphalt emulsion.

Moisture traps should be provided between the vacuum receivers and the dry vacuum pumps, designed to remove the greatest percent possible of the moisture contained in the air in the vacuum line after it has passed through the vacuum receiver.



Komline-Sanderson Coiled Spring Vacuum Filter
(Note external piping of vacuum lines to drum)

Package Units

Several of the manufacturers now offer package units which include the vacuum filter, vacuum pump, blower, filtrate pump, chemical feed equipment and conditioning tank. For filter units up to a size of at least 100 sq. ft., the package units appear to be both practical and economical. The manufacturer in the case of the package units usually assumes responsibility for all of the equipment included therewith. He purchases the appurtenant items of equipment and assembles them in his shop. The assembly therefore requires a minimum of space and minimizes installation problems. This arrangement may be advantageous when the owner is in need of maintenance, repair, and replacement service.

General Acid-Resisting Construction

Equipment which handles ferric chloride conditioned sludge should be of acid-resisting construction. Specifications quite commonly provide for a protective rubber coating 3/16-in. thick or more, or a coating of fibrated asphalt at least 3/16 in. thick. The protective coating is customarily applied to the inside of conditioning and mixing tanks, the inside of the filter tank, both ends of the drumheads, the overflow chamber, the agitator blades and arms, the mixing shaft and other parts of the equipment not otherwise suitably protected or of acid-resisting materials.

Fundamentals Of Chlorination Of Sewage And Waste*

by EDWARD W. MOORE, *Assoc. Prof. of San. Chem., Harvard University, Cambridge, Mass.*

CHLORINE is probably the most powerful and flexible tool that chemical science has provided for the sanitary engineer. As an illustration of its versatility, we may examine its application to the wastes which we discharge into our streams. Here we demand that it do three major jobs: first, the elimination of pathogens from the wastes, so that the stream may be safely used as a source of water supply or as a place for bathing; second, the destruction or modification of decomposable organic substances contained in the wastes, so that their biochemical oxygen demand may be reduced, or at least delayed in its exertion; and third, the destruction of chemicals present in the waste which would react directly with oxygen, such as sulfides, sulfites, and ferrous iron.

On all of these jobs, chlorine is capable of turning in a creditable performance, provided that we take account of the limitations inherent in its chemical behavior. It is this behavior, and the concurrent limitations on the powers of chlorine, that are to be discussed in this article.

Chemistry of Chlorine And Chlorine Compounds

Liquid Chlorine. The element itself has the formula Cl_2. It is a greenish gas at ordinary temperatures and pressures, can readily be liquefied at pressures of the order of 50-150 psi., and can thus be contained in pressure vessels and tanks. The commercial product is 99.99% pure, and is the cheapest form of chlorine where the consumption is large. The gas is quite soluble in water, forming a solution containing 0.7 per cent by weight at 68°F. and 0.5 per cent at 92°F. It therefore lends itself readily to solution-feed, but requires special regulating devices to control the flow of the gas by regulation of pressure or vacuum in a chamber.

Certain precautions need to be observed in its application. It is a highly toxic substance even in small concentrations, as shown by Table I, taken from a publication of the Wallace and Tiernan Co.

Table I

PHYSIOLOGICAL EFFECTS OF CHLORINE

	ppm. by volume, in air
Least detectable by odor	about 3.5
Produces throat irritation	15
Produces coughing	30
Dangerous for 30-minute exposure	40-60
Rapidly fatal	1000

Other forms of chlorine or chlorine compounds, include the hypochlorites of calcium and sodium; the ammonia-chloramine compounds formed between chlorine and ammonia; chlorine dioxide; and such special complex chlorine compounds as succinchlorimide, $(CH_2\ CO)_2\ NCl$, Halazone, $HOOC\text{-}C_6H_4\text{-}SO_2\ NCl_2$, and chloramine-T, $CH_3\ C_6\ H_4\ SO_2\ Na\ NCl$.

"Available" Chlorine

The active portion of all of these chlorine compounds is that part of the chlorine content of the compound which possesses a valence number higher than —1. Since the amount and kind of active chlorine vary widely in the compounds, it has become the practice to measure the activity in terms of the oxidizing power of the compound, and express this in terms of equivalent chlorine. This measure is called the percentage of available chlorine.

To the eternal mystification of students, the available chlorine of a compound may amount to more than the total chlorine content of the compound, especially in the case of the hypochlorites. If the quantity had been called "chlorine equivalent" or some other more accurate name, the difficulty would probably not arise. It may help to remember that "per cent available chlorine" is really analogous to "alkalinity as calcium carbonate", and that there might even be no chlorine at all in the compound, or, in other words, that it is equally legitimate to speak of the "available chlorine" of ozone, hydrogen peroxide, or any other oxidizing agent in view of the way in which "available chlorine" is defined and determined.

For purposes of illustration, the percentage of "available chlorine" by weight that would be found for various pure compounds is computed and compared with the percentage of chlorine by weight actually present in the compound. (See Table II.)

Behavior of Chlorine Compounds In Water

When chlorine, Cl_2, dissolves in water, it hydrolyzes immediately according to the reaction

$$Cl_2 + H_2O \rightleftharpoons HOCl + H^+ + Cl^-$$

The equilibrium condition is given by the expression which follows:

Table II

ACTUAL AND "AVAILABLE" CHLORINE IN PURE COMPOUNDS

Compound	Mol Wgt.	Mols* of Equivalent Cl	Per cent of Chlorine, by weight	
			Actually Present	"Available"
Cl_2	71	Cl_2	100.0	100.0
$CaClOCl$	127	Cl_2	56.0	56.0
$NaOCl$	74.5	Cl_2	47.7	95.4
$Ca(OCl)_2$	143	$2Cl_2$	49.6	99.2
NH_4Cl	51.5	Cl_2	69.0	138.0
$NHCl_2$	86	$2Cl_2$	82.5	165.0
Cl_2O	87	$2Cl_2$	81.7	163.4
$HOCl$	52.5	Cl_2	67.7	135.4

*Number of mols of chlorine that would have an oxidizing capacity equivalent to one mol of the compound.

*Presented before the Univ. of Mich. School of Public Health Inservice Training Course in Technical Problems in Sewage and Industrial Waste Disposal, and here published by permission.

$$\frac{[HOCl]\,[H^+]\,[Cl^-]}{[Cl_2]} = K_h$$

The value of K_h is such that in waters of pH value above 3.0 and for concentrations of total chlorine below 1000 ppm., no measurable quantity of Cl_2 exists in the solution, all chlorine being present as HOCl.

For example, Jakowkin's[1] value for K_h at 15°C. is 3.16×10^4, and if we assume a solution receiving a dose of 7.1 ppm. total chlorine (10^{-4} molar) at a pH value of 7.0, the ratio of HOCl to Cl_2 present after reaction will be

$$\frac{(HOCl)}{(Cl_2)} = K_h \times \frac{1}{(H^+)\,(Cl^-)} = \frac{3.16 \times 10^4}{10^{-4} \times 10^{-4}} = 3 \times 10^{12}$$

Furthermore, it has been shown that the rate of the reaction is such that equilibrium is reached within a few seconds at ordinary temperatures. Hence the conclusion is inescapable that when water or sewage is treated with gaseous chlorine under any condition likely to be encountered in practice, all the chlorine is at once converted to HOCl.

Hypochlorous Acid in Water

Hypochlorous acid is a weak acid and consequently ionizes in water according to the equation

$$HOCl \rightleftharpoons H^+ + OCl^-$$

This equilibrium is instantaneous and reversible, and is governed by the equation

$$\frac{[H^+]\,[OCl^-]}{[HOCl]} = K_1$$

or, by rearrangement,

$$\frac{[OCl^-]}{[HOCl]} = \frac{K_1}{[H^+]}$$

Thus any free chlorine or hypochlorite added to water will immediately distribute itself into the species HOCl and OCl^-, and the ratio of the two will be controlled entirely by the pH value of the water. This fact is of the greatest importance with respect to disinfection, since HOCl and OCl^- differ greatly in killing power.

Substitution of the proper values of K_1 (estimated from the results of a number of workers as 3.3×10^{-8} for 20°C. and 2.1×10^{-8} for 0°C.) will reveal that at pH 5.0 or below almost all of the chlorine is present as HOCl, whereas above pH 10.0 nearly all of it exists as OCl^-.

Table III and Fig. 1 show the approximate percentages of total chlorine present at HOCl and OCl^- at various pH values for temperatures of 0° and 20°C.

All of the hypochlorites, when placed in water, will immediately ionize to give OCl^- ion:

$$Ca(OCl)_2 \rightarrow Ca^{++} + 2OCl^-$$

The hypochlorite ion will then reach precisely the same equilibrium as given above by combination with the hydrogen ions of the water:

$$H^+ + OCl^- \rightleftharpoons HOCl$$

It must be pointed out that the pH value that will control is the pH value reached after the addition of the chlorine compound, not the original pH value of the water. Since the addition of chlorine tends to lower the initial pH and the addition of hypochlorites tends to raise it, the addition of equivalent amounts of chlorine in the form of chlorine or hypochlorites will not be expected to yield the same results unless the amounts added are so small that the pH value of the water remains unaffected.

Chloramines

Hypochlorous acid reacts with ammonia and with many of the more complex derivatives of ammonia to produce compounds known as chloramines. These retain some of the oxidizing properties of the hypochlorous acid, so that they respond to the ortho-tolidine and starch-iodide tests in varying degrees. They also retain the disinfecting properties of hypochlorous acid in some degree. We cannot be sure that the responses of these compounds to the usual tests for chlorine are correlated with their efficiencies as disinfecting agents until all possible forms of chloramines have been investigated.

Table III

PERCENTAGES OF CHLORINE AS HOCl AND OCl^- AT DIFFERENT pH VALUES

pH	Percentages of Total Chlorine as			
	HOCl		OCl^-	
	0°C	20°C	0°C	20°C
4.0	100.0	100.0	0.00	0.00
5.0	100.0	99.7	0.00	0.3
6.0	98.2	96.8	1.8	3.2
7.0	83.3	75.2	16.7	24.8
8.0	32.2	23.2	67.8	76.8
9.0	4.5	2.9	95.5	97.1
10.0	0.5	0.3	99.5	99.7
11.0	0.05	0.03	99.95	99.97

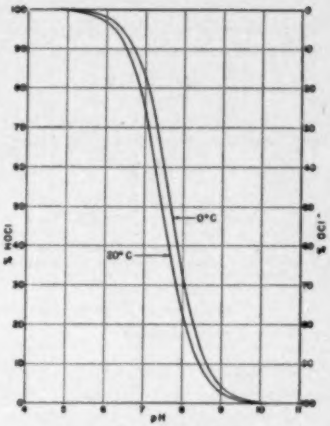


Fig. 1. Relative Amounts of HOCl and OCl^- Present at Various pH Values

There is some indication that some of the chloramine compounds formed when sewage is chlorinated respond to the usual tests for chlorine without having any appreciable disinfecting action. Others do not respond appreciably to chlorine tests, but seem to possess material disinfecting powers.

The simple ammonia chloramines have been studied by a considerable number of workers, and a detailed investigation into equilibria and rates of formation of these compounds is being carried on at the Laboratories of Sanitary Engineering of the Harvard Graduate School of Engineering. It is known that three chloramines are formed, in accordance with the following reactions:

$$\underset{}{NH_3} + HOCl \rightarrow \underset{\text{monochloramine}}{NH_2Cl} + H_2O$$

$$\underset{}{NH_2Cl} + HOCl \rightarrow \underset{\text{dichloramine}}{NHCl_2} + H_2O$$

$$\underset{}{NHCl_2} + HOCl \rightarrow \underset{\text{nitrogen trichloride}}{NCl_3} + H_2O$$

The early work of Chapin, done at concentrations much higher than those employed in chlorination, indicated that above pH 8.5 only monochloramine is formed, that varying mixtures of mono- and dichloramine appear between pH 8.5 and 5.0, and that dichloramine is the sole form existing at pH 5.0 to 4.4, below which nitrogen trichloride begins to appear. It is not assured that these relationships will hold for the concentrations of chlorine used in practice. However, the Harvard Research previously mentioned, which has employed ultra-violet spectroscopy to differentiate between chloramines in solution, has shown that the ratio of mono- to dichloramine is controlled by the equilibrium

$$2\,NH_4Cl + H^+ \rightleftharpoons NH_4^+ + NHCl_2$$

The mathematical expression controlling this equilibrium is

$$\frac{(NH_4^+)\,(NHCl_2)}{(H^+)\,(NH_4Cl)^2} = K_{eq.}$$

and the value of the constant has been determined as 6.7×10^6 at about 25°C. For the concentrations of total chloramine used in practice, and for a weight ratio of total chlorine to ammonia nitrogen of 5 to 1, Table IV gives the relative percentages of monochloramine and dichloramine present at various pH values. These values agree approximately with those of Chapin, and indicate that the differences in distribution are not too great between concentrated and dilute chloramine solutions. However, Chapin's statements as to the formation of nitrogen trichloride may be inaccurate, and it may exist at much higher pH values. The disinfecting efficiency of chloramine solutions will be dependent on the ratio of the different chloramines present and therefore on the pH value.

Table IV

CHLORAMINE DISTRIBUTION AT VARIOUS pH VALUES

pH	Percentage of Chlorine Present as Monochloramine	Dichloramine
5	16	84
6	38	62
7	65	35
8	85	15
9	94	6

Rate of Formation of Ammonia Chloramines

The rate at which chlorine reacts with ammonia to form the chloramines is also under study at Harvard.[1] So far, the rate of the first step, which results in monochloramine,

$$NH_3 + HOCl \rightarrow NH_2Cl + H_2O$$

has been investigated. The reaction is proved to be in accordance with the equation as written. This reaction is very much influenced by the pH value of the solution. The kinetic expression for the rate of a reaction of this type is

$$-\frac{dc}{dt} = k_r \cdot C \cdot N$$

where

$-\frac{dc}{dt}$ = instantaneous rate of reaction, mols of HOCl or NH_3 per minute

C = concentration of chlorine, mols per liter

N = concentration of ammonia N, mols per liter

The effect of pH value on the rate of reaction at 25°C. is shown in Table V.

Between pH 6.5 and 11.0 the rates are too fast to be measured accurately by experimental methods, but can be calculated from the experimental values available by means of theoretical considerations. These calculations show that the maximum rate of formation of monochloramine appears at pH 8.3; at this point k_r is about 5×10^6. From these values the rate of formation of monochloramine can be calculated for any given set of conditions.

For example, a water at 25°C. receiving 0.8 ppm. of chlorine and 0.32 ppm. of ammonia nitrogen will convert 99 per cent of the chlorine to monochloramine in 1 minute at pH 8.3, but at pH 5 the required time will be 210 minutes, and at pH 11.0 it will be 90 minutes. The reaction rates also vary greatly with temperature, increasing by a factor of 2.0 to 2.5 for every 10°C. increase in temperature.

The rates of formation of dichloramine are being similarly studied, but the work is not yet complete. The optimum pH value is lower, as would be expected, but the variation in rate with pH forms a very similar pattern. Some work has also been done on the rate of the breakpoint reaction; this reaction evidently starts with dichloramine, which decomposes into unknown end-products. The observed rates are dependent on the pH value and chlorine-ammonia ratio; a maximum in the rate occurs at a pH of about 7.3.

Table V

MEASURED RATES OF FORMATION OF MONOCHLORAMINE AT VARIOUS pH VALUES

pH	$k_r \times 10^{-6}$
4.6	8.9
4.71	13.0
6.11	220.0
6.49	580.0
10.95	92.0
12.05	7.4

Determination of Chlorine

Since the different species of chlorine compounds outlined above have disinfecting efficiencies differing greatly from each other, a rational study of disinfection by chlorine compounds demands accurate methods for determining the amounts of the various species present. Assuming that the equilibrium relationships between HOCl and OCl^- and between ammonia and the various chloramines are, or can be, worked out, it will be sufficient to differentiate between chlorine present as "free residual chlorine" (HOCl and OCl^-) and that present as "combined" residual chlorine (chloramine). It will eventually be necessary to have means for differentiating between the ammonia chloramines and the complex, less active chloramines that may be formed when chlorine is added to sewage.

The starch-iodide test and the standard orthotolidine test are of no value for this purpose, since they respond to all of the chlorine compounds discussed, and probably to many of the complex chloramines. The ortho-tolidine-arsenite test differentiates between hypochlorite chlorine and the ammonia chloramines, by virtue of the fact that the reaction with ortho-tolidine is much more rapid for the former than for the latter. The addition of sodium arsenite stops the reaction after all the hypochlorite has reacted and, at least approximately, before the ammonia chloramines have reacted.

The O.T.A. test is being investigated in our laboratory, and the results show that a correction must be applied to the readings obtained in order to compensate for the amount of ammonia chloramine that reacts with ortho-tolidine before the arsenite is added.

$$\text{Hypochlorite Cl} = \frac{(\text{O.T.A.}) - F_t(\text{O.T.})}{1 - F_t}$$

This equation (O.T.A.) represents the reading obtained with ortho-tolidine followed by arsenite, and (O.T.) represents the reading obtained with ortho-tolidine alone. F_t is really the fraction of chloramine which reacts in the time between the addition of the ortho-tolidine and the arsenite, and depends on three factors: the amount of ortho-tolidine solution used, the time elapsing between the two additions, and the temperature, as shown in Table VI. The accuracy of the test may thus be improved by lowering the temperature or by cutting down the time elapsing between the additions of ortho-tolidine and arsenite. Since the reaction between ortho-tolidine and the chloramines appears to be catalyzed by chloride ion, it may be possible to improve the differentiation by using some acid other than HCl. This factor is now under investigation.

Chlorine in Sewage

In sewage, the presence of large amounts of substances that react with chlorine must be considered.

Table VI

CORRECTION FACTORS FOR THE O.T.A. TEST

Temp. °C.	Temp. °F.	Value of F, for 5—ml O.T. 20 sec.	5—ml O.T. 3 sec.	1—ml O.T. 20 sec.	1—ml O.T. 3 sec.
0	32	0.077	0.012	0.034	0.005
5	41	0.12	0.019	0.054	0.008
10	50	0.18	0.029	0.082	0.013
15	59	0.26	0.044	0.12	0.019
20	68	0.34	0.061	0.16	0.026
25	77	0.50	0.109	0.26	0.044

It is rare that sufficient chlorine is added to produce a permanent appreciable content of HOCl and OCl^-. The active chlorine remaining in sewage after ordinary chlorination will be present largely in the form of ammonia chloramines and the more complex chloramines formed by reaction of the chloramine with nitrogenous organic compounds. The bulk of the chlorine added will of course have been converted to inactive chlorine. At normal sewage pH values, the formation of ammonia chloramines takes place in a few minutes; however, as previously shown, if the pH value is high or low, the slow rate of ammonia-chloramine formation may permit the persistence of HOCl or OCl^- residuals for some time.

Our present methods of determining chlorine residuals in sewage, the ortho-tolidine and starch-iodide methods, are thus of dubious significance with respect to disinfection, since they represent a complex of chloramino-compounds of highly variable disinfecting powers. This complex must be untangled before we can proceed with fundamental studies of sewage disinfection; so long as this is not done, empirical studies are bound, as they do, to present confusing and conflicting results. A chlorine residual of, say, 0.5 ppm. in one sewage does not necessarily have the same killing power as an equal residual in another sewage, because the chlorine compounds present may be, and probably are, of different composition. Moreover, the killing power of the chlorine compounds present while the chlorine demand was being exerted may have been entirely different, and killing goes on side by side with the exertion of demand. Within reasonably narrow limits of sewage composition, the differences may be small. In the following sections lies what little information can be gleaned from empirical studies.

Disinfection by Chlorine Compounds

It is now pretty well established that oxidation of the living cell is not involved in disinfection by chlorine compounds, but that these compounds enter into reactions with certain of the essential enzymes of the cell, and thus kill by stopping the metabolic processes of the cell. Green and co-workers[6] have studied a number of these enzyme-chlorine reactions. Two factors are thus involved in the ability of a compound to disinfect: its ability to penetrate the cell, and its reactivity toward the cell enzymes. On a more practical plane, the factors that determine the efficiency of disinfection are the nature of the disinfecting agent, the concentration of this agent and the time allowed for its action, the number of organisms present, and the temperature.

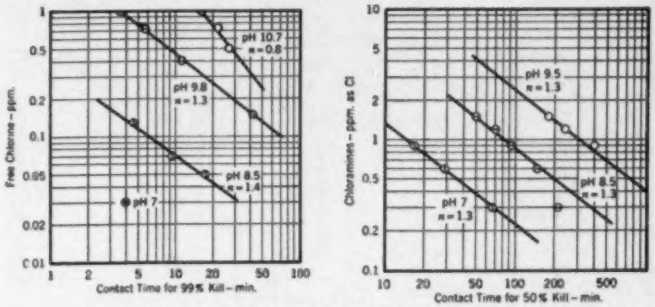


Fig. 2. Free Chlorine and Chloramine Requirements vs. Contact Time

(Free Chlorine) *(Chloramine)*

Rate of Disinfection

The rate at which disinfection proceeds with time under ideal conditions, namely, constant concentration of disinfecting agent, constant temperature, and the presence of a single species of bacterium of which all individuals are equally susceptible to the agent, is given by Chick's law,

$$\log \frac{N_o}{N} = rt$$

where N_o and N represent the numbers of organisms present at the beginning and after t minutes, respectively, and r is a constant which measures the rapidity of the kill. It is not surprising to find that few experimental studies conform exactly to Chick's law. Generally the rate of kill decreases as time goes on—this reflects the survival of the more resistant individuals, the decline in concentration of the active agent, and a number of other interfering factors. More complicated formulae have been devised to express results of individual studies, but their applicability is limited.

The important thing is that the killing of organisms by disinfecting agents follows a logarithmic law:—that it is the ratio of the numbers of bacteria present before and after disinfection that is significant, not the numbers themselves. This gives theoretical aid and comfort to the engineer's natural tendency to use a percentage:—the terminology "time required to kill 50 per cent, or 90 per cent of the bacteria present" has a real significance, and the total number of bacteria is of less importance. The engineer's tendency to use logarithmic scales and plots is also in line with reality.

Concentration of Organisms

Far too little is known about the effect of total numbers of organisms on the rate of disinfection. Such results as do exist indicate that the effects are slight with changes in the total number as great as tenfold. This is a field of research that would have considerable significance for the disinfection of sewage, where the numbers of organisms are high and widely variable.

Concentration of Disinfectant

An examination of data from many sources shows that the time required to effect a constant percentage of kill of bacteria or other organisms by means of any disinfectant is dependent on the concentration of the disinfectant in the following manner:

$$C^n t = \text{Const.}$$

where C represents the concentration of disinfectant, t represents the time required to kill a selected percentage of the organisms, and n is a numerical value which depends on the disinfectant, the organism, and the temperature. (A series of such plots is shown in Fig. 2, with the left hand diagram representing free chlorine requirements for a 99 per per cent kill of bacteria and the right hand diagram representing chloramine requirements for a 50 per cent kill.) This equation is purely empirical and has as yet no theoretical justification. The constant n is a positive number, and its numerical value, in the studies so far made, ranges from 0.75 to 2.00, with 1.00 as the most common value. It is a measure of the change of killing efficiency of the disinfectant with change of concentration. Table VII, from the work of Fair, Morris, and Chang[8], shows some of the values obtained for various disinfectants and organisms.

Temperature

The effect of increased temperature on disinfection is to increase the kill; the rate of increase follows the law which governs the rate of increase of all chemical reactions with temperature, namely

$$\log \frac{t_1}{t_2} = \frac{E(T_1 - T_2)}{4.575(T_1T_2)}$$

where the t values represent times required for equal percentages of kill at the absolute temperatures T_1 and T_2, and E is a constant characteristic of disinfectant and organism.

This is a cumbersome expression, and can be simplified by taking the temperature interval as 10°C., whereupon the right-hand side of the equation becomes nearly constant and the ratio t_1/t_2, called Q_{10}, represents the relative increase in disinfection rate for a 10° increase in temperature.

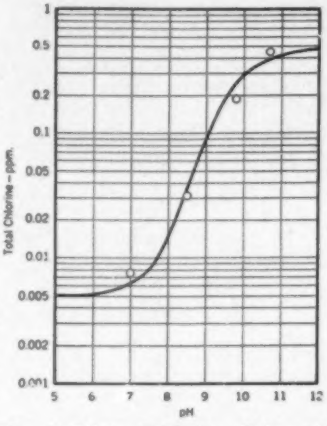


Fig. 3. Relative Disinfecting efficiency of HOCl and OCl^-

Table VII

VALUES OF n FOR CHLORINE COMPOUNDS

Substance	Value of n for Cysts of E. histolytica	Enteric Bacteria	B. Anthracis Spores	B. Metiens Spores
HOCl	1.0	1.6	0.67	0.9 1.0 0.95
OCl^-	2.0	0.75		
$NHCl_2$	1.0	0.75	0.8	0.8
NH_2Cl	1.0			

For example, if $Q_{10} = 2.00$, the rate is doubled for every 10° rise. Some values of Q_{10} for *E. Coli*, computed by Fair et al[6] from the work of Butterfield, are given in Table VIII.

Table VIII

VALUES OF Q_{10} FOR E. COLI

Aqueous Chlorine pH	Q_{10}	Chloramines pH	Q_{10}
7.0	1.65	7.0	2.08
8.5	1.42	8.5	2.28
9.8	2.13	9.5	3.35
10.7	2.50		

Determination of Relative Disinfecting Power

With the foregoing as a basis, it becomes possible to evaluate the efficiency of any disinfecting agent against any organism, subject to the limitations of experimental techniques. The values so obtained can then be applied to practical problems of waste disinfection, with the assurance that the conclusions drawn rest on sound fundamental knowledge. It is necessary only to take sufficient trouble to identify the agents which are involved in our disinfection operation, and to have at hand, or to secure by controlled experiments, data on the efficiencies of these agents against the organisms with which we are concerned.

It is unfortunately not true that the effectiveness of chlorine compounds against the various waterborne pathogens is the same for all organisms, nor is the relative efficiency of the different chlorine compounds the same for all organisms. The groups of organisms in which we are most interested are the following:

1. *Esch. coli*, which, although not a pathogen, is the important type of organism of water contamination.

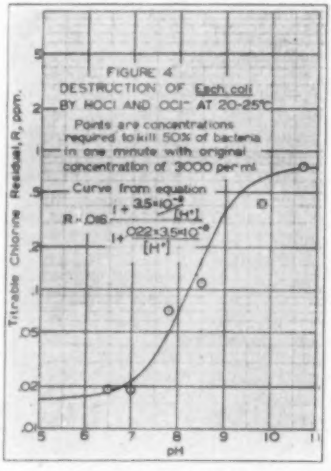


FIGURE 4
DESTRUCTION OF Esch. coli
BY HOCl AND OCl⁻ AT 20-25°C
Points are concentrations
required to kill 50% of bacteria
in one minute with original
concentration of 3000 per ml
Curve from equation
R = .016 (1 + 3.5×10⁻⁸/[H⁺]) / (1 + .022×3.5×10⁻⁸/[H⁺])
Titrable Chlorine Residual, R, ppm.
pH

Fig. 4. Destruction of E. Coli by HOCl and OCl^- at 20-25° C

2. The enteric bacteria, Eberthella, Shigella, Salmonella, and Vibrio species.

3. The intestinal protozoa—for example, E. histolytica.

4. Worms, such as the Schistosomes.

5. Viruses, such as that of infectious hepatitis.

In a general way, the results indicate that the enteric bacteria are most easily destroyed by chlorine compounds, and that the cysts of the enteric protozoa are the most resistant. Until further evidence is available, the use of amoebic cysts as indicator organisms for disinfection evaluation is thus suggested.

Efficiencies of HOCl and OCl^-

It has been apparent for a long time from the decrease in observed disinfection efficiencies with increasing pH values that HOCl is much more effective than OCl^-. Now that values are available for the dissociation constant of HOCl, the proportions of HOCl and OCl^- in any disinfection study involving these compounds alone can be evaluated, and also the relative efficiencies.

If R is the total residual of chlorine as HOCl and OCl^- required to produce a given percentage of kill of a specified organism, A is the concentration of HOCl alone necessary to produce this kill, and B is the ratio of the efficiency of OCl^- to HOCl, the equation is

$$R = A\frac{1 + \frac{K}{(H^+)}}{1 + B\frac{K}{(H^+)}}$$

where K is the previously given ionization constant of HOCl and (H^+) is the hydrogen-ion concentration.

For a kill of 99 per cent of *E. coli* in 30 minutes at 2 to 5°C., the results lead to the equation

$$R = 0.005\frac{1 + \frac{2.2 \times 10^{-8}}{(H^+)}}{1 + 0.012\frac{2.2 \times 10^{-8}}{(H^+)}}$$

(A plot of this equation is shown in Fig. 3.)

B is 0.012, thus indicating that OCl^- is about 1/80 as effective as HOCl against *E. coli* under the conditions given. In other words, the work done by HOCl alone (at pH 5.0) in a concentration of 0.005 ppm. as chlorine requires, at pH 10.7, where OCl^- is the main constituent, a total chlorine content of about 0.4 ppm.

For a 50 per cent kill of *E. coli* in 1 minute at 20-25°C., calculations

from results by Butterfield, Wattie, Megregian, and Chambers[7] give a required dose of 0.016 ppm. of HOCl as chlorine and about 0.75 ppm. of OCl^-, so that under these conditions OCl^- is about 1/45 as effective as HOCl. (See Fig 4.)

Results are also available for 100 per cent kill of 30 cysts per ml. of *E. histolytica* at 3°C. and 23°C. and contact times of 10 minutes and 30 minutes. Here HOCl is much more effective relative to OCl^- than it is even for *E. coli*, as the following table shows. The required HOCl residuals for 30-min. contact are 1.2 ppm. at 23°C. and 7.5 ppm. at 3°C.

Table IX

EFFECTIVENESS OF OCl^- RELATIVE TO HOCl AGAINST AMOEBIC CYSTS, FOR 100 PER CENT KILL

Temperature	Relative Effective Ratio OCl^- to HOCl 10-min. Contact	30-min. Contact
3° C.	1/100	1/200
23° C.	1/250	1/400

For other organisms of interest, no results are as yet available. It is reasonable to assume, however, that many of them will lie between the two extremes of the values for *E. coli* and *E. histolytica* cysts. For spores of B. anthracis and B. metiens at 25°C., 30 minutes contact, the HOCl residuals required for 100 per cent kill are 3 ppm. and 2 ppm., respectively.

Efficiencies of NH_2Cl and $NHCl_2$

The relative efficiencies of mono- and dichloramine have been investigated in a similar way, although the results are much less complete. (See Fig. 5.) For cysts of *E. histolytica* under the same conditions as previously stated, it is indicated that dichloramine is about 60 per cent as efficient as HOCl, and monochloramine about 22 per cent as efficient, for a contact time of 30 minutes. At pH 4.5, where dichloramine only is present, a residual of 2 ppm. gives 100 per cent kill of cysts, whereas at pH 10.0, with monochloramine only, the required residual is about 5.5 ppm.

A few experiments have been made on spores of B. anthracis. For these the efficiency of dichloramine was 15 per cent of that of HOCl for a 30-minute contact period, and that of monochloramine was too low to be measured. Calculations based on results by Butterfield and Wattie[7] indicate that for a 50 per cent kill of the enteric bacteria in 1 minute, an amount of dichloramine equal to 80 to 100 times the required HOCl is necessary, the activity of monochloramine appearing again to be negligible. It must be noted that this does not mean that monochloramine is entirely ineffective, only that no measurable effect is observable in 1 minute. Evaluations of killing efficiencies on the enteric organism are difficult because of the short contact times that must be employed.

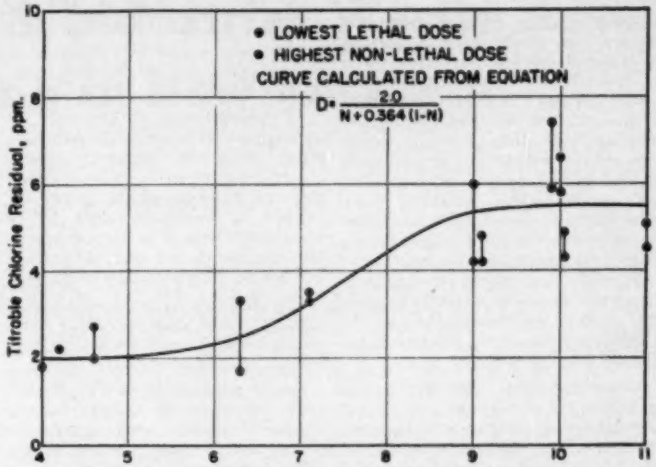


Fig. 5. Destruction of Cysts of *E. histolytica* by Chloramines in 30 min. at 23° C. (30 cysts per ml.)

Disinfecting Efficiencies of Other Chlorine Compounds

No definite experimental evidence is yet at hand on the disinfecting efficiencies of chlorine compounds other than those discussed above, although certain inferences can be made. Most of the organic chloramines have disinfecting efficiencies lower than those of the ammonia chloramines, and certainly much lower than that of HOCl; the efficiency ratios to HOCl are probably 1 to 10 or lower. The theory has been propounded that their disinfecting action is due entirely to the small quantities of HOCl and OCl^- formed from them by dissociation, and that the compounds themselves have no disinfecting action. A proposition of this nature is difficult to prove or disprove at present, but the fact that the cysticidal efficiency of Halozone is not significantly affected by pH value is evidence against it.

Chlorine dioxide is too new for its efficiency to have been fully evaluated. (Ed. Note:—Two recent articles on this subject have appeared, one on bactericidal properties in the July issue of the *J.A.W.W.A.* and the second on sporicidal properties in the August issue of *Water & Sewage Works*.)

Application to Sewage and Waste Chlorination

In the chlorination of sewage and wastes, the economics of the problem usually precludes the addition of sufficient chlorine to satisfy all of the chlorine demand and to convert all ammonia and nitrogen compounds to chloramines. Unless this is done, the existence of HOCl in chlorinated sewage or waste is an ephemeral one, and the chlorine compounds which remain are unfortunately those of relatively low disinfecting efficiency.

If the pH value is sufficiently low, the best of the chloramines, namely dichloramine, will be formed. Some consideration might be given to pH reduction by the addition of acid along with chlorination. This would not only throw the chloramine balance in a direction favorable to dichloramine, but would also reduce the rate of formation of chloramines, as previously shown, thus permitting a longer persistence of HOCl. Studies along this line are recommended to those interested in improving the practice of sewage and waste chlorination.

Real knowledge of the processes by which bacteria are killed in chlorinated sewage and wastes will depend on the development of techniques to identify and determine the species of chlorine compounds present in the chlorinated mixture. At present this is a large order, but there are new analytical methods which are promising. One of them, the phenyl-arsene oxide method[8], gives higher readings for residuals in sewage than those obtained by

the ortho-tolidine method. This may serve to explain why, in many instances, the killing of coliforms in chlorinated sewage continues when no residual can be determined with ortho-tolidine. We have probably gone as far as we can go in correlating kills obtained in sewage and wastes with chlorine residuals as determined by the ortho-tolidine and starch-iodide methods. They have led to answers which, while extremely useful in any particular case, cannot be extended to other situations with any degree of certainty. If we are to produce results of general utility, the formidable task of identifying the active chlorine compounds present must be faced.

There are some other factors involved in the chlorination of sewage and wastes which do not have to be considered in the chlorination of water. In sewage and wastes the total numbers of bacteria are very large, and, as previously pointed out, it is by no means certain that rates of kill are independent of numbers of organisms, even when the factor of additional chlorine demand accompanying the organisms is eliminated. Organisms which would be killed if freely exposed to the chlorinated liquid are often buried in clumps of other organisms or in particles of inert matter, and thus are protected from contact with disinfecting agents.

Reduction of B.O.D. by Chlorination

It has been known since the early 1920's that the addition of chlorine to sewage and wastes effects a measurable reduction in the observed B.O.D., and that this reduction is, at least in part, a permanent reduction, involving elimination or alteration of substances capable of exerting B.O.D. A large amount of research has indicated that the application to sewage of enough chlorine to produce a trace of residual after 15 minutes reduces the 5-day B.O.D. by 15 to 35 per cent. This reduction amounts to about 2 ppm. of B.O.D. per ppm. of chlorine taken up. Largely on the basis of indirect evidence, it has been concluded that three kinds of reactions are involved:

(1) Direct oxidation, resulting in destruction of B.O.D.-exerting compounds.

(2) Substitution of chlorine for hydrogen. When this substitution takes place on nitrogen atoms, chloro-amine compounds having more or less bactericidal power are formed, as previously noted. When the substitution is on carbon atoms, the compounds are not bactericidal but are no longer available as food.

(3) Addition to unsaturated compounds. This again produces compounds that are not bactericidal but are not available as food.

As to whether the 5-day B.O.D. reduction observed results from a reduction of the total amount of decomposable material or a reduction of the rate at which B.O.D. is exerted, or both, the evidence has not been decisive. Recent studies by Snow[9] have indicated that both the total amounts of B.O.D and the rates of exertion are reduced. The two factors together account for the observed reduction in 5-day B.O.D.. Snow found that chlorination of fresh sewage to a trace of residual at 15 minutes gave reductions of only 10 per cent, as compared to the 15 to 35 per cent usually accepted. Chlorine doses as high as 100 to 300 ppm. were required to secure reductions as high as 35 per cent. Chlorination to the "breakpoint", i.e. to a free $HOCl$-OCl^- residual, gave reductions as high as 75 per cent, but the amounts of chlorine required would be prohibitive.

Snow accounted for the difference between his 10 per cent reduction and those cited in the literature by showing that the condition and stage of decomposition of the sewage had a great influence on the B.O.D. reduction secured by satisfaction of the 15 minute chlorine demand. For example, if the sewage were held under aerobic conditions for ½ to 2 days before chlorination, then reductions of 25 to 40 per cent of the 5-day B.O.D. could be accomplished by chlorination to a 15 minute residual. One day of anaerobic incubation of the sewage permitted a 23.6 per cent reduction of 5-day B.O.D., as compared with an 11.1 per cent reduction on the same sewage when fresh. Plain aeration of sewage for 30 to 60 minutes, followed by chlorination, also resulted in considerable increases in the 5-day B.O.D. reduction secured. Snow suggested this process as a possibility for sewage treatment to secure results intermediate between those of plain sedimentation and complete treatment.

Conclusion

The chlorination of water, sewage, or waste has been shown to be a complex problem, involving, as it does, not a single disinfecting agent but a number of derivatives of varying effectiveness. Enough has been done, however, to show that the problem can be solved, that very specific values can be assigned to each of the many chlorine derivatives, and that we can in many cases predict exactly how much of each derivative will be present under any given circumstances. As our knowledge grows more complete, we will have to rely less and less on trial-and-error methods and will be able to correlate and extend experimental information without the confusion and disagreement that prevail at present. We will also know in what directions to move in order to improve our practical disinfection techniques, and what to avoid in chlorination practices. The scientific knowledge of today generates the practical advances of tomorrow, and so it will be with chlorination.

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Fortunate Glendale, R.I.

Water Supply Envy of Neighbors

In the sunny hillside community of Glendale New Village, near the northern boundary of Rhode Island, 28 families live in a model housing development created by the Harrisville Company, a textile concern. Not only does the company sweep the streets, and prune the shrubs but it also provides water from a 417 ft. well. This well water contains exactly 1.5 ppm. of fluoride ion, just the correct amount for the reduction of dental decay. No statistical records have been kept of DMF teeth, but everyone agrees that they don't have much trouble with their teeth, something most of the rest of the state cannot lay claim to.

N. Y. Sewage & Industrial Wastes Assn. Annual Meeting in New York

A Report

by HARRY A. FABER* *Editorial Associate, Water and Sewage Works*

Presidents

Incoming
J. M. MacCrae
Chicago Pump Co.
Syracuse, N.Y.

Outgoing
J. W. Johnson
Gen. Mgr.
Bfo. Sew. Auth.
Buffalo, N.Y.

THE Twenty-third Annual Meeting of the New York Sewage and Industrial Wastes Association, in New York City, January 19-20, 1951, was attended by more than 300 members and guests. The technical program provided discussions of interest to those concerned with the administration and operation of waste treatment plants—whether of the municipal or industrial type.

Featured at the luncheon session, on the first day of the meeting, were addresses by W. H. Wisely and by Gordon M. Fair. Presiding at the luncheon was John W. Johnson, Association President, and General Manager of the Buffalo Sewer Authority. George E. Symons headed the Committee on Local Arrangements and the Water and Sewage Works Manufacturers' Association held open house at a Social Hour; this event concluded the sessions on the first day.

W. H. WISELY, Executive Secretary, Federation of Sewage and Industrial Wastes Associations, presented current and pertinent information relating to the supply of critical materials. He reported, for the first time, on the organization of a water, sewage, and industrial wastes joint committee representing the American Public Health Assn., the American Water Works Assn., and the Water and Sewage Works Manufacturers Assn. and the Federation of Sewage and Industrial Wastes Assns. Representatives of the joint committee had met, earlier in the week, with Gen. William H. Harrison, Defense Production Administrator, in Washington, to present their claim on critical materials. Mr. Wisely said the committee had emphasized the importance of needs for water and waste construction in connection with the defense effort; the joint committee hopes to obtain a more suitable claimant agency than the presently assigned Housing and Home Finance Agency. Individual problems can be directed to regional offices of the National Production Administration. Chlorine allocation (upon which an NPA order has since been issued), selective service matters, and DO priorities were also reviewed in the discussion.

Ken. Allen Award
Seth G. Hess
Dir. & Ch. Engr.
Inter State San. Comm.
New York City

GORDON M. FAIR, Chairman, Division of Engineering Sciences, Harvard University, Cambridge, Mass., titled his address "Let Us Look at the Record of Sanitation." The first part of his review was devoted to quotations from a variety of early writings on sanitary problems, and the second part to a showing of lantern slides illustrating accomplishments shown by the record. His paper provides a wealth of references, descriptive of scenes dating back through the past two hundred years, and quoted in the words of contemporary writers—Jonathan Swift, Charles Dickens, and the reports of medical inspectors. These recited examples of gross negligence, and constitute a record Mr. Fair termed "too little known."

The need for sanitary reform in New York City was clearly evident in the death rate, averaging 38 per thousand, during the five years preceding 1866, which led to the organization of the Sanitary Society. Stream pollution problems were in existence long ago, according to articles in British journals which described the human and industrial waste pollution of the Thames River. The record, illustrated by lantern slides, shows how many and extensive have been the accomplishments in reducing the incidence of typhoid fever, malaria, and other contagious diseases. Prof. Fair concluded by pointing to the next frontier of the sanitary engineering; air pollution abatement.

Kenneth Allen Award

The Memorial Award Committee of the Association named SETH G. HESS as recipient of the Kenneth Allen Award for the year 1950. This award, made on the basis of the best technical paper published by a member of the New York Association, was presented by Alexander G. Martin, Chairman of the Committee. The paper cited, "A Rational Determination of Storm Overflows from Intercepting Sewers," was published in the February, 1950, issue of "Sewage and Industrial Wastes." Mr. Hess, in accepting the award, desired that the co-author and others who assisted should be credited with their contributions to a consolidation of material.

New Officers

The following officers were elected to serve for the coming year:

Luncheon Speakers

W. H. Wisely
Exec. Sec'y
Fed. S.&I.W.A.
Champaign, Ill.

Prof. G. M. Fair
Chairman
Div. Engng. Sci.
Harvard Univ.
Cambridge, Mass.

*Research Chemist, The Chlorine Institute, Inc., New York, N. Y.

President
John M. McCrea
Chicago Pump Co.
Syracuse, N. Y.

Vice-President
Walter R. Schreiner, Dis. San. Engr.
State Dept. of Health
Glens Falls, N. Y.

Exec.-Secretary
R. C. Sweeney, Dist. San. Engr.
State Dept. of Health
White Plains, N. Y.

Treasurer
J. C. Brigham, Sr. San. Engr.
State Dept of Health,
Albany, N. Y.

The following were elected new members of the Executive Committee:

Arthur J. Scanlon, New York City
Raymond W. Hess, Buffalo, N. Y.
Harry A. Faber, New York City

Wm. H. Larkin, Assoc. San. Engr., State Dept. of Health, Albany, N.Y., was elected to represent the association as Director on the Bd. of Directors of the Federation, serving a three year term beginning in Oct. 1951. He succeeds Dr. George E. Symons, Managing Editor, *Water & Sewage Works*, New York City.

It was announced that the next meeting of the Association will be held jointly with the New England Sewage Association, on June 7-8, in Springfield, Mass., at Hotel Kimball. Members of both Associations will be represented on the program.

Technical Sessions

Civil Defense

"Relationship Between Sewage and Waste Treatment Works and the Civil Defense Program" by S. T. Barker, P. E., Ass't. Director, Bureau of Environmental Sanitation, State Dept. of Health, Albany, N. Y.

Mr. Barker pointed out that the whole Civil Defense program is of recent development and that only general responsibilities can be discussed at present. Personnel of the Bureau of Sanitation has been detailed to assist in the development of a sound plan for both water and sewage utilities. To date, mutual aid programs have been effectuated for water systems and milk producers, but the general sanitation program is largely undeveloped.

The State, exclusive of New York City, is divided into 22 zones—each of which is headed by a zone coordinator. Mutual aid between communities and between zones can thus be coordinated in the event facilities are disrupted. A water works inventory is now in progress as a part of the plan for water utilities, and a mutual aid plan for sewage and industrial waste systems is under way. District, County, and Municipal employees of the State Department of Health will be prepared to assist utility officials.

Basis of the CD plan is maintenance of treatment plant operation. This will require inventories of equipment, organization of trained crews for emergencies, and emergency sources of power. Repairs of pumping equipment will be considered of primary importance, but repairs to underground sewers may not be a significant requirement. It will be necessary for plant officials and zone coordinators to jointly establish needs for the functioning of individual plants; advance planning to this and is extremely important.

General concern over this application of civilian defense needs was apparent in the discussion which followed Mr. Barker's paper. Detailed information was requested with reference to procedure following destruction by atomic bombing (residual radioactivity and its effect on repair procedures), and to the establishment of priorities for needed equipment.

Vice Pres.
W. R. Schreiner
Dist. Engr.
St. Dept. H'lth
Glens Falls, N.Y.

Fed. Director
Wm. A. Larkin
Chief
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St. Dept. H'lth
Albany, N.Y.

Pollution Abatement

"Pollution Abatement Status in the North Atlantic Drainage Basins" by Kenneth C. Lauster, Sen. San. Engr., Officer in Charge, North Atlantic Drainage Basins, USPHS, Div. of Water Pollution Control, New York, N. Y.

The Public Health Law of 1948 (PL. 845) directs the development of a program for the abatement of pollution—and the collection of data is the beginning step. This is the first time information on sewage and industrial wastes data has been compiled on a drainage basin basis. Existing files of State and Interstate agencies have been drawn upon to provide a present picture and a future plan.

In presenting a preview of the completed report, now being cleared for publication, Mr. Lauster noted that the North Atlantic Drainage Basin involves 30 million population, of whom 23 million are served by sewerage systems. Some 32 per cent of the nation's industrial production and 26 per cent of its industrial wastes are in this area. Roughly, one-half of the treatment works in operation are considered adequate—but the number of industrial waste treatment plants required lags behind those for municipal wastes. Preliminary action is encouraging, since 34 municipal plants and 43 industrial plants are presently under construction, and orders have been issued for the construction of 243 additional industrial waste treatment plants.

Secretary
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White Plains, N.Y.

Treasurer
J. C. Brigham
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Albany, N.Y.

A comprehensive view of the status of pollution abatement progress must take into account the advances in planning and research, and in the development of adequate legislation. All states in this Basin area now have reasonably adequate laws for the control of pollution. Mr. Lauster considers present progress to be gratifying and to demonstrate the basic premise of cooperation as an effective means of accomplishing control.

Industrial Waste Symposium

"Industrial Waste Treatment Problems in New York State" was the subject of a symposium. Presiding chairman was R. W. Hess, Head, Pollution Research and Operating Improvements, National Aniline Division, Allied Chemical and Dye Corp., Buffalo, N. Y.

An an introduction to the symposium, Mr. Hess pointed to the extensive variety and large volume of industrial wastes existing in New York State. He called attention to the growth in industrial membership in the Association (it has tripled in the past three years) as an indication of the progressive attitude shown by industry. Examples of the specific problems which exist are provided in the papers presented.

Canneries

"CANNING WASTES" by Wm. A. Ryan, Consulting Chemist, Rochester, N. Y.

Mr. Ryan evaluated canning at a two billion dollar industry (baby food alone is over 1.75 million dollars), and cited New York State as fourth, during 1950, among all states in the dollars paid to farmers for raw vegetables. There are over 160 canning plants in this state.

Cleanliness is an important factor in the industry and the wastes contain a large volume of wash water.

Separate disposal of waste food solids is important, plant wash-up water segregation is increasingly practiced, and some specialty processors purchase only washed foods.

Programmers

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Waste treatment processes range from the simple provision of mechanical screening and lagooning, to secondary treatment by biological filters. Treatment results are only fair or poor when canning plants located in small villages discharge wastes to the municipal sewage treatment plant. A rather unusual condition exists at many canning plants located along the Barge Canal: the state permits discharge of well screened and coagulated wastes to the canal, and it generally provides an adequate degree of dilution. Special reference was made to the lime coagulation of apple processing wastes as a recent development. The precipitated sludge solids are disposed of on land.

Dairies

"DAIRY WASTES" by Clifford W. Watson, San. Engr., Dairymen's League Coop. Assn., Inc., Lincoln Park, N. J.

Mr. Watson noted that no other New York State industry was so widely distributed over the state although there is a trend toward consolidation of small, scattered plants into larger units.

The wastes from this industry include much lost product, and primary consideration is being given to reducing losses—as good business and as reduction of pollution. The most common type of treatment, particularly in small processing plants, is that provided by septic tanks. Good results are obtained by treatment of dairy wastes in simple aeration plants, and the number of activated sludge type treatment plants is increasing.

Dairy wastes contain a high percentage of organic material readily susceptible to biological treatment—except for the high lactose content of the waste, which may cause objectionable acidity. The real test of a treatment process is in its operation under the supervision of the dairy plant personnel. Frequently, adaptations may be necessary to simplify standard treatment processes for the sake of simplicity and easy operation.

Food Processing

"FOOD WASTES" by G. B. Stolley, Plant Manager, Standard Brands, Inc., Peekskill, N. Y.

This is a broad classification and was broadly commented upon by Wm. Stolley. Specific experience was cited with reference to distilling, malt syrup, and yeast factory wastes—all of which have been found susceptible to organic treatment. Many such wastes, however, can best be treated for complete or partial recovery of solids; return from the sale of solids may be profitable or, at least, materially reduce treatment costs.

Reduction in volume of wastes is generally of first importance, then sedimentation, digestion of solids, and effluent treatment on trickling filters may follow. Mesophilic anaerobic digestion studies have been made on several wastes of exceptionally high organic content. Three stages of digestion may be required, providing 6 to 8 days for a 75 per cent reduction in B.O.D. These stages yield respectively 60, 30, and 10 per cent of the total removal; but the third stage is important to supply seed material for the first stage, even though it accomplishes little removal of B.O.D. Anaerobic digestion was indicated as applicable to a wide variety of wastes, but pilot plant studies are important to establish proper control and operating conditions.

Biologicals

"PHARMACEUTICAL WASTES" by James M. Brown, Sanitary Engineer, Lederle Laboratories Division, American Cyanamid Company, Pearl River, N. Y.

These wastes constitute rather unique, but rapidly expanding, industrial waste treatment problem. Biological products produced through animals—such as smallpox vaccine, gas gangrene antitoxin, diphtheria antitoxin, etc.—are responsible for large quantities of animal waste. New products—biologicals and antibiotics—create new problems: the wastes contain many tons of organic material for each ounce of finished product.

The need for products of the Lederle Laboratories has resulted in expansion from 700 employees in 1940 to 2800 at the end of the last war, and now in further growth to nearly 4,000 employees. The plant effluent is discharged to the Town of Pearl River sewage treatment plant; the effluent of the Town plant is discharged to a small stream forming a part of a privately operated public water supply. The treatment problem is further

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complicated by the lack of dilution: during the summer months the dilution, at times amounts to less than 5 to 1. The industry's wastes include solid wastes (infected manures, glassware, waste filter cakes, garbage, etc.) which are destroyed in a Nichols incinerator.

The liquid wastes from pharmaceutical plants producing antibiotics and biologicals include strong fermentation beers, inorganic solids, washings, chemical wastes, and condenser waters. Penicillin broth can be evaporated to a slurry and spray dried, but aureomycin fermentation filtrate cannot because of the caramelizing effect of the sugar content. The combined industrial waste and the fermentation filtrate is treated on high rate trickling filters. It has been found important to control low pH values by the addition of caustic soda to the wastes, maintaining a pH value of 6.7 in the storage tank.

The present treatment plant following the waste storage tank, includes: a grease removal unit, two stages of aeration, primary clarifiers, high rate trickling filters with recirculation, and discharge of treated wastes with by-passed weak sewage to the Town plant. Vacuum filters are employed to dewater sludge from the

clarifiers. The high ash content and the large amounts of diatomaceous earth in the sludge provide an excellent sludge conditioner; only lime is required to produce a filterable sludge. However, the diatomaceous earth causes excessive wear on the copper cloth of the vacuum filter and on the chain drive of the Town plant clarifier.

Pulp and Paper

"PULP AND PAPER WASTES" by Frank R. Burde, Atlantic States Resident San. Engr., National Council for Stream Improvement for the Pulp, Paper and Paper Board Industries, New York, N. Y.

Lantern slides were employed to illustrate the varied types of mills

Programmers

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(over 100) and of products in New York State. A large proportion of these mills joined the National Council to keep informed on waste treatment developments and requirements. Progress has been even more rapid since passage of legislation setting up a water pollution control authority in New York State. Pulp and paper plants have been divided on the basis of watershed location, to facilitate joint studies and efficient use of investigative personnel.

Indications to date are that known methods of treatment will be applicable to all wastes discharged. The major volume of wastes is white water—the easiest to treat of all these wastes. Individual studies may be required at specific mills but, in general, research has already shown the size of the problem, the research, and the cooperation which will be required.

Metal Wastes

"EFFECT OF METAL WASTES ON SEWAGE TREATMENT PLANT DESIGN" by Robert D. Mitchell, James Cassanos, and Daniel A. Okun, Malcolm Pirnie Engineers, New York, N. Y.

Mr. Mitchell, Associate Engineer with the organization, presented the paper. This was a report of a study made for the City of Waterbury, Conn., to determine the feasibility of digestion of Municipal wastes containing toxic materials. One-third of the U. S. tonnage of brass is processed in Connecticut, and the City of Waterbury has a large proportion of metal industry. Metal processing industries are almost entirely located along the Naugatuck River; except for small plants, their wastes are largely excluded from municipal sewers and are discharged directly to the river. Extensive investigations were made of undesirable wastes in the sewage, as they related to the sewage treatment plant now under construction.

Copper and cadmium were found to be present in objectionable concentrations, and some acid and some alkaline wastes were considered important. At the time these studies were conducted, background information concerning the effect of metallic constituents on sludge digestion processes was very limited. Laboratory studies were undertaken early in 1949, and an extensive sampling program was followed for one week. Slides were shown to illustrate the sewage characteristics, particularly copper, revealed by the studies.

The data obtained indicated the Waterbury industrial waste ordinance was ineffective in reducing copper to a tolerable concentration. Not only are copper wastes discharged to the sewers but, in addition, many industrial plants use river water which contains about 12.5 ppm. of copper and discharge that water to the sewers. The copper concentration in the sewage appears to average about 2.6 ppm. and to be definitely above the concentration which can be tolerated in a sludge digestion process.

Operator Certification

"CERTIFICATION OF SEWAGE AND WASTE TREATMENT PLANT OPERATORS" by Alexander Rihm, Jr., Sanitary Engineer, Bureau of Environmental Sanitation, State Department of Health, Albany, N. Y.

The State's Public Health Law, in its Sanitary Code, states that regulations may be provided for the qualification of Municipal water and sewage plant operators. Section F of the Code, as of October, 1937, provides this regulation and exempts operators employed at a prior date.

Mr. Rihm clearly described the three grades of sewage treatment plant operators for which qualifications have been established; they are based on physical, mental, and character requirements. It is evident that different degrees of skill are indicated by the type of plant to be operated and by the population served by the plant. In 1949, grades IB and IIB were added to the original three grades, to approve operators capable of qualification only in one specific treatment plant.

Qualifications have been in effect over 13 years: Certifications include 125 operators in Grade I, 270 in Grade II, and more than 600 in Grade III. There is no certification required of operators in private or industrial waste treatment plants, and no intention that their certification will be required. It is believed that industry will be sufficiently concerned with its investment to provide proper plant operation.

Sewer Rental in New York

"PRELIMINARY RERORT ON SEWER RENTAL FOR NEW YORK CITY" by

Programmers

J. M. Brown, Jr.
San. Engr.
Lederle Labs.
Pearl River, N.Y.

W. A. Ryan
Cons. Chem.
Rochester
N. Y.

Richard H. Gould, Director, Division of Sewage Disposal, Dept. of Public Works, New York, N. Y.

While New York has been inhabited for some 287 years, it was only 21 years ago that the city undertook to treat its sewage. Already the program of construction is beginning to crowd a figure of $300 million. In common with other municipalities, it has been difficult to secure sums adequate for building and for operation; hence an ordinance establishing separate sewer charges, dated July 1, 1950.

Collection of sewer rents is a relatively simple law in execution and in administration. The sewer rent charge is based on the water supplied to property by the municipal water department, and is equal to one-third of the water charge. Provision is made for the sewer rent charge where a separate water supply exists. The sewer rent revenues constitute a sewer fund to pay for mortgage, operation, and repair costs of the system.

New York City's sewer charges were estimated to provide about $15 million per year, but the amount may be only $14 million because of presently reduced use of water. Mr. Gould reported there has been little objection to the sewer charges imposed—

which he considers indicative of progress in civic consciousness.

Sanitary District

"THE NEW ROCHELLE SANITARY SEWER DISTRICT IN THE COUNTY OF WESTCHESTER" by E. H. Feldman, Director, Department of Public Works, New Rochelle, N. Y.

This community has grown from a village to a city of 60,000 population, principally by gradual development of residential areas. Shore line pollution has grown with the community, and has been solved only to the extent of constructing an outfall sewer into Long Island Sound, back in 1925. Studies of the problem, and of plans for its solution, have been made repeatedly but unsuccessfully. There was little popular conception of the problem or of the requirements.

Pressure was finally brought by the Interstate Sanitation Commission in 1948, but financing costs had risen to an amount which would alone nearly reach the debt limit of the city—and leave funds for nothing else. The formation of a sewer district, to include New Rochelle and adjacent Larchmont, was proposed, approved by the Westchester County Board of Supervisors, submitted to the taxpayers and passed. The issuance of more than $4.9 million dollars in bonds is thereby authorized to construct a sewage treatment plant and deep water outfall. Most impressive in Mr. Feldman's description, was the determined and highly successful effort expended to make the public understand the proposal to be decided by their vote.

Herrin, Ill., Adopts Garbage Grinders

Herrin, Ill., is the third city to require garbage grinding in the home and disposal via the sewerage system, as the only method by which the city will offer garbage disposal service.

Like Jasper, Ind., the City of Herrin has purchased a supply of household garbage grinders for resale to home-owners on a cost-plus basis with time payments.

The Herrin authorities expect no difficulty handling the additional load in the form of garbage at their new $300,000 sewage treatment plant. The new plant is considered of ample capacity to handle the garbage loading in addition to the sewage load.

Jasper, Ind., was the first city to adopt garbage disposal grinders and Dearborn, Mich., was the second, based on an estimated annual saving of $190,000 by eliminating garbage collection.

Sales Engineering

John Wiley & Sons, Inc., New York has published a book entitled "SALES ENGINEERING" by Bernard Lester. This book is concerned with "the art of selling equipment and services that require engineering skill in their selection, application and use." Also described is the type of work this involves, the opportunities it offers and the methods—skills and techniques. Sales Engineering, consisting of 226 pages, is available from John Wiley & Sons, Inc. at $3.00 per copy.

Robbing Peter To Pay Paul

The Virginia, Minn. city council voted to stop paying its electric power and water bills. The action was designed to save the city $30,000 a year for the general fund, which is being rapidly depleted.

Of course it means that the power and water departments of the city will be short that amount of money for their operations. It is a case of one municipal agency holding out on another since the electric and water departments are municipally owned. The consumers will have to pay more for service, while not receiving any reduction in taxes.

Akron Ohio Calibrates Tank Trucks

Uses Large Edition of Meter Test Tanks

When the Department of Weights and Measures of Akron, Ohio, wanted to set up a tank truck testing and calibration station, they went to the Akron Water Department for advice. After the City Sealer, Robert K. Slough had talked with Wendell R. La Due, Gen. Mgr. of the Water Dept., it was decided to try a company which was in the business of making calibrating tanks for water meters.

Thus it was that Mr. Slough journeyed to Wabash, Ind., and talked with the Ford Meter Box Co. He wanted accurately calibrated tanks to be used in checking tank trucks which ordinarily haul gasoline, fuel oil, and milk. That was a large order for John Ford and his boys, but they obtained two 500 gallon tanks, fitted them with valves, sight glasses, and calibrations.

The result is that now on hill beside a road in Akron stand these oversize meter testing tanks, and Mr. Slough's department is expecting an income of $4500 a year from the calibrations of tank trucks which come in for the service. More than $1000 in fees has already been received. Accuracy of the calibrating tanks is one part in 11,000.—Being in the water works business leads to some funny sidelines at times.

THE EDITOR'S COMMENTS

Chlorine Supply and Cooperation

Chlorine Order M-31, covering chlorine supply for public health needs, was issued by the National Production Administration on January 23rd, just too late to be included in our February issue. Elsewhere in this issue the order is reproduced in full.

Chlorine Order M-31 is specifically drawn to provide for rated orders on chlorine required for water and sewage chlorination and to insure equitable distribution of all such rated orders among all producers and distributors of liquid chlorine.

In our January issue we were able to present on this page a pre-view of the basic components of the Chlorine Order, which was at the time in the course of production. We are pleased to find that the order, with certain objected to interim changes removed, finally emerged in essentially the form and wording which was given in our January issue pre-view.

Some of the most important elements of N.P.A. Order M-31 are the following:

(1) Through rated orders chlorine for water and sewage treatment is assured 1951 users in an amount at least *equal to* that purchased in 1950.

(2) Where more chlorine is to be needed in 1951, than in 1950, cause must be shown in a special application and claim, with ample supporting facts, filed with the National Production Authority, (Ref: M-31, Chemicals Div.) Washington 25,, D.C.

From what we can ascertain additional supply of chlorine above 1950 use is not going to be easy to secure if the chlorine is for *new uses* and such new or extended use can not be shown to be *essential* to the protection of public health.

(3) Chlorine producers and distributors who supplied a user of chlorine for water, sewage and industrial waste treatment in 1950 will be required, without exception, to accept rated chlorine orders from the *same* user during 1951 in an amount at least equal to that supplied the user in 1950. However, the 1950 user, if he so desires, and is able to without the aid of the Order may purchase his chlorine requirements elsewhere.

What this says is that a user is not bound by Order M-31 to continue with his 1950 chlorine supplier if he does not wish to, and is so fortunate as to locate another producer or distributor who will take him on as a new customer and assume the obligation of supplying him with his 1951 chlorine requirements. Failing in this, the user can demand chlorine from his 1950 supplier in the amount supplied in 1950, regardless of any desire on the part of the supplier to reduce his overall chlorine commitments for sanitation purposes. It is a fact that at least one chlorine supplier has attempted to rid himself of sanitation chlorine sales on grounds that it constitutes the least attractive chlorine business and is fraught with many headaches, including that of getting the empty containers back for refilling in reasonable time. Fortunately N.P.A. Order M-31 protects the 1950 customer against being left to hunt for another possible chlorine supplier; and, likewise, protects other chlorine suppliers from having to absorb what has come to be the least desirable chlorine business.

(4) As to spacing of deliveries of chlorine, the Order calls for monthly deliveries. It stipulates that orders for public health chlorine which carries the rating "Certified Under N.P.A. Order M-31" shall be placed with producers at least 15 days in advance of the first day of the month in which the chlorine is to be used. In the case of distributors, who must keep ahead with chlorine supplied by the producer, the requirement is 20 days advance ordering instead of 15 days.

For heavy seasonal or peak uses of 1951 chlorine requirements the Order permits the ordering of as much as 25 per cent of the entire year's chlorine needs in a single month. This proviso was added, but not without reluctance for fear of abuse, in order to take care of heavy seasonal chlorine requirements in sewage disinfection, in which the entire year's chlorine use takes place within a period of four to six months.

(5) The Order requires the chlorine user to maintain adequate records, such as the receipt of chlorine shipments, container numbers, records of placing containers in service and removal therefrom, and dates of return of containers to the producer or distributor. Such records are to be held subject to examination by N.P.A. if occasion demands.

As to penalties for violation of requirements of the Order, or furnishing false information, or concealment of pertinent facts, or diversion of chlorine procured under the M-31 authorization to any other uses than for sanitation or public health protection, the persons involved are subject to criminal prosecution, fine and imprisonment.

(6) If trouble is experienced by any old or new user in procuring chlorine. Order M-31 provides for assistance of N.P.A. in aiding the prospective user to locate a source of supply.

The Order makes no reference to a Claimant Agency or to the desirability of working through such agency, but it would seem logical if not decidedly helpful to proceed through and with the assistance of the now existant Claimant Agency—the U.S. Public Health Service—in applications for chlorine for *new* uses or additional chlorine for whatever purpose. Also, a supporting statement from the State Health Department would likewise prove advantageous.

The Order does not go into the matter of types or sizes of chlorine containers, and, therefore until the situation changes water and sewage works managers may be called upon to temporarily accept chlorine in containers of different capacity than those heretofore supplied. Getting chlorine to the user is the primary consideration.

Chlorine users can do one thing which will go a long way toward facilitating the delivery of chlorine with minimum delay and expense. I am referring to that old "bottle-neck," the chlorine container. At this time it is not easy to procure metal for making chlorine containers and cylinder valves. It is, therefore, doubly important that existing containers be kept in fullest use and movement. A resumption of World War II practice of return of empty containers as rapidly as feasible, meaning in small shipments, will relieve a situation which could result in the inability of suppliers to maintain a uniform and dependable flow of chlorine supply to users.

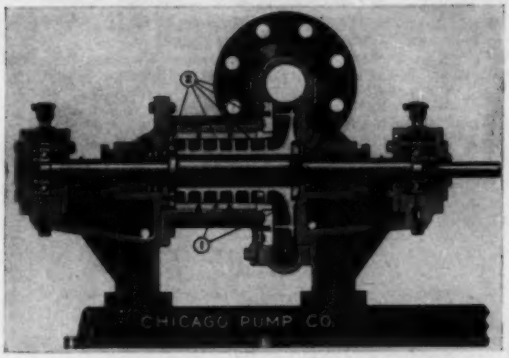
L. H. Enslow

CHICAGO SCRU-PELLER PUMPS

for SLUDGE

The Scru-Peller Pump was specifically designed to handle sludge. Coarse stringy material is cut and cannot wrap or bind the impellers.

1. **SCREW and IMPELLER** are keyed on the shaft and held firmly against a shoulder on the shaft by a nut. The screw has two flights; and the impeller has two blades. Each flight in the conveyor connects directly with its own blade of the impeller.
2. **CUTTING EDGES.** There are four stellited cutting bars and a shear ring in the screw housing. There are four more cutting bars in the pump casing. The stellited edges of the screw and the edges of the impeller blades act against the cutting bars and shear ring, completely chopping all coarse solid material into small pieces that cannot clog or slow the pump.



CHICAGO FLUSH-KLEEN EJECTORS

for SEWAGE

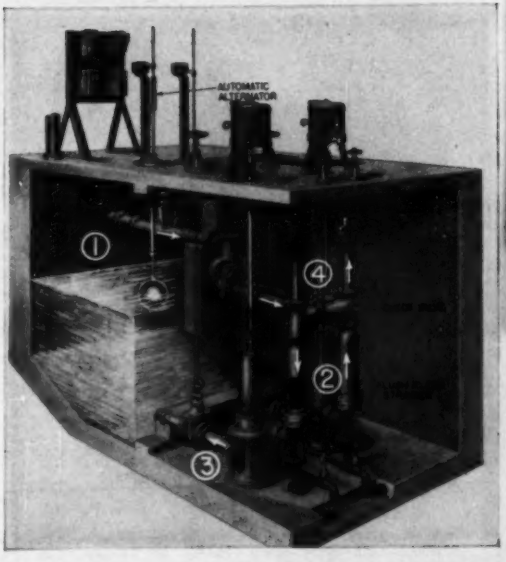
FLUSH KLEEN pumps provide automatic, trouble-free service in sewage lift-stations. They require no manual attention except periodic lubrication and inspection. No labor is required for disassembling and cleaning clogged pumps. FLUSH KLEENS are absolutely clog proof. The impellers handle nothing but strained sewage, minimizing wear and maintaining pump balance. They are the only absolutely clog proof sewage pump. The FLUSH KLEEN will pump anything that will pass through the pipe regardless of type or quantity of material.

FILLING WET WELL

1. Sewage flows through inlet pipe.
2. Coarse matter is retained on strainer.
3. Strained sewage flows through idle pump to wet well.

PUMPING

3. Strained sewage is pumped from wet well.
2. Coarse matter is backwashed from strainer.
4. Special check valve closes; sewage and coarse matter are pumped to sewers.



CHICAGO PUMP COMPANY

SEWAGE EQUIPMENT DIVISION

2300 WOLFRAM STREET — **CHICAGO 18, ILLINOIS**

Flush Kleen. Scru-Peller. Plunger. Horizontal and Vertical Non-Clog Water Seal Pumping Units. Samplers.

Swing Diffusers. Stationary Diffusers. Mechanical Aerators. Combination Aerator-Clarifiers. Comminutors.

Meetings Scheduled:

Mar. 5-8—Pueblo, Colo. *(Hotels Congress, Vail, Whitmore)*
ROCKY MOUNTAIN ANNUAL SCHOOL FOR WATER AND SEWAGE PLANT SUPERINTENDENTS. Sec'y, Geo. J. Turre, P. O. Box 600, Denver, Colo.

Mar. 11-15—College Station, Texas *(Texas A. & M.)*
TEXAS WATER & SEWAGE WORKS ASSOCIATION. Sec'y, V. M. Ehlers, 501 West 33rd St., Austin 2, Texas.

Mar. 13-16—New York City, N.Y. *(Hotel Statler)*
NATIONAL ASSOCIATION OF CORROSION ENGINEERS. Exec.-Sec'y, A. B. Campbell, 919 Milam Bldg., Houston, Texas.

Mar. 14-16—Atlantic City, N.J. *(Hotel Haddon Hall)*
NEW JERSEY SEWAGE & INDUSTRIAL WASTE ASS'N. Sec'y, Michael S. Kachorsky, Box 283, Manville, N. J.

Mar. 15—Boston, Mass. *(Statler Hotel)*
NEW ENGLAND SECTION A.W.W.A. Sec'y, George G. Bogren, Weston & Sampson, 14 Beacon Street, Boston 8, Mass.
NEW ENGLAND WATER WORKS ASSOCIATION. Sec'y, Jos. C. Knox, 73 Tremont Street, Boston 8, Mass.

Mar. 28-30—Grand Canyon, Ariz. *(El Tovar Hotel)*
ARIZONA SEWAGE AND WATER WORKS ASSOCIATION. Sec'y, Mrs. Helen Rotthaus, Capitol Bldg., Phoenix, Ariz.

Mar. 28-30—Baton Rouge, La. *(Louisiana State Univ.)*
LOUISIANA CONFERENCE ON WATER SUPPLY & SEWERAGE. Sec'y, Dan L. Winters, c/o Gulf Public Service Co., Inc., New Iberia, La.

Mar. 28-30—Chicago, Ill. *(LaSalle Hotel)*
ILLINOIS SECTION A.W.W.A. Sec'y, J. L. Hart, U.S. Pipe & Foundry Co., 122 So. Michigan Ave., Chicago 3, Ill.

Apr. 5-6—Old Point Comfort, Va. *(Hotel Chamberlain)*
VIRGINIA INDUSTRIAL WASTES & SEWAGE WORKS ASSN. Sec'y, A. H. Paessler, 815 E. Franklin Street, Richmond 19, Va.

Apr. 5-6—Albany, N.Y. *(Hotel Ten Eyck)*
NEW YORK SECTION A.W.W.A. (SPRING MEETING). Sec'y, Rollo K. Blanchard, 50 West 50th Street, New York 20, N. Y.

Apr. 9-11—Hot Springs, Ark.
ARKANSAS WATER & SEWAGE CONFERENCE. Sec'y, Harrison Hale University of Arkansas, 118 Chemistry Bldg., Fayetteville, Ark.

Apr. 11—Orono, Me. *(University of Maine)*
MAINE WATER UTILITIES ASSOCIATION. Sec'y, Earle A. Tarr, Supt. Water District, Winthrop, Me.

Apr. 11-13—Hays, Kansas *(Lamar Hotel)*
KANSAS SECTION A.W.W.A. Sec'y, H. W. Badley, 640 Highland St., Salina, Kans.
KANSAS SEWAGE WORKS ASSOCIATION. Sec'y, Dwight F. Metzler, State Board of Health, Univ. of Kansas, Lawrence, Kans.

Apr. 16-19—Madison, Wis. *(University of Wisconsin)*
12TH SHORT COURSE FOR SEWAGE PLANT OPERATORS. Gerard A. Rohlich, Director, College of Engineering, Univ. of Wisconsin, Madison 6, Wis.

Apr. 19—Storrs, Conn.
NEW ENGLAND WATER WORKS ASSOCIATION (Joint meeting with) CONNECTICUT WATER WORKS ASSOCIATION. Sec'y, Jos. C. Knox, 73 Tremont Street, Boston 8, Mass.

Apr. 19-20—Lincoln, Neb. *(Cornhusker Hotel)*
NEBRASKA SECTION A.W.W.A. Sec'y, E. Bruce Meier, 201 Mechanic Arts Bldg., Univ., of Nebraska, Lincoln, Neb.

Apr. 19—Helena, Mont. *(Hotel Placer)*
MONTANA SEWAGE WORKS ASSOCIATION. Sec'y, H. B. Foote, State Board of Health, Helena, Mont.

Apr. 20-21—
MONTANA SECTION A.W.W.A. Sec'y, Arthur W. Clarkson, State Board of Health, 1036—8th Ave., Helena, Mont.

Apr. 25-28—Fresno, Calif. *(Hotel California)*
CALIFORNIA SEWAGE WORKS ASSOCIATION. Sec'y, Lawrence H. Cook, Box 696 Menlo Park, Calif.

Apr. 29-May 4—Miami, Fla.
ASS'NS. (Annual Convention) W. H. Wisely, 325 Convention.) Exec.-Sec'y, Harry E. Jordan, 500 Fifth Avenue. New York 19, N. Y.
(Meetings and Exhibits in the Dinner Key Auditorium.) Application blanks for hotel accommodations were mailed to members by the Association Headquarters in December. All reservations will be cleared through the A.W.W.A. office.

May 15-16—Vancouver, B.C., Canada *(Hotel Vancouver)*
PACIFIC NORTHWEST SEWAGE WORKS ASSOCIATION. Sec'y, Wm. P. Hughes, City Hall, Lewiston, Idaho.

May 17-19—
PACIFIC NORTHWEST SECTION A.W.W.A. Sec'y, O. P. Newman, Boise Water Department, Boise, Idaho.

May 17—Manchester, N.H.
NEW ENGLAND WATER WORKS ASSOCIATION. Sec'y, Jos. C. Knox, 73 Tremont Street, Boston 8, Mass.

May 21-23—Winnipeg, Man., Can. *(Alexandria Hotel)*
CANADIAN SECTION A.W.W.A. Sec'y, Dr. A. E. Berry, Ontario Department of Health, Parliament Building, Toronto, Ont.

June 4-5—Grand Rapids, Mich. *(Hotel Pantlind)*
MICHIGAN SEWAGE & INDUSTRIAL WASTES ASSN. Sec'y, Donald M. Pierce, State Dept. of Health, Room 334 Administration Bldg., Lansing 4, Mich.

June 7-8—Springfield, Mass. *(Hotel Kimball)*
NEW ENGLAND SEWAGE & INDUSTRIAL WASTE ASSN. Sec'y, Walter E. Merrill, State Dept. of Health, 511A State House, Boston, Mass.
(Joint Meeting)
NEW YORK SEWAGE & INDUSTRIAL WASTES ASS'N. Sec'y, Ralph C. Sweeney, 21 N. Broadway, White Plains, N. Y.

June 11-14—Tuscaloosa, Ala. *(University of Alabama)*
ALABAMA WATER & SEWAGE WORKS ASSOCIATION. Sec'y, Alex O. Taylor, Box 69, Auburn, Ala.

June 13—York Harbor, Me. *(Joint Conferences)*
MAINE WATER UTILITIES ASSOCIATION. Sec'y, Earl A. Tarr, Winthrop, Me.
NEW ENGLAND WATER WORKS ASSOCIATION. Sec'y, Jos. C. Knox, 73 Tremont St., Boston, Mass.
NEW HAMPSHIRE WATER WORKS ASSOCIATION. Sec'y, W. A. Healy, 17 Capitol St., Concord, N. H.

June 20-22—Columbus, Ohio *(Neil House)*
OHIO SEWAGE AND INDUSTRIAL WASTES TREATMENT CONFERENCE. Sec'y, J. E. Richards, 302 Departments Bldg., Columbus 15, Ohio.

Aug. 20-22—State College, Pa. *(Nittany Lion Inn)*
PENNSYLVANIA WATER WORKS OPERATORS' ASSOCIATION. Sec'y, R. Rupert Kountz, Penna. State College, State College, Pa.

Aug. 22-24—
PENNSYLVANIA SEWAGE & INDUSTRIAL WASTES ASSOCIATION. Sec'y, B. S. Bush, Dept. of Health, Kirby Health Center, Wilkes-Barre, Pa.

Sept. 10-12—Boston, Mass. *(Hotel Statler)*
NEW ENGLAND WATER WORKS ASSOCIATION (Annual Convention). Sec'y, Jos. C. Knox, 73 Tremont Street, Boston 8, Mass.

Sept. 11-13—Marshalltown, Iowa *(Hotel Tall Corn)*
IOWA SEWAGE WORKS ASSOCIATION. Sec'y, Leo Holtcamp, P.O. Box 310, Webster City, Ia.

Sept. 12-14—Minneapolis, Minn. *(Hotel Nicollet)*
MINNESOTA SECTION A.W.W.A. Sec'y, Leonard N. Thompson, 216 Court House Bldg., St. Paul, Minn.

Sept. 17-19—Louisville, Ky. *(Kentucky Hotel)*
KENTUCKY-TENNESSEE SECTION A.W.W.A. KENTUCKY-TENNESSEE INDUSTRIAL WASTES & SEWAGE WORK ASSN. Sec'y, R. P. Farrell, 420 Sixth Ave., N., Nashville 3, Tenn.

Sept. 19-21—St. Joseph, Mich. *(Whitcomb Hotel)*
MICHIGAN SECTION A.W.W.A. Sec'y, T. L. Vander Velde, 2609 E. Saginaw Street, Lansing 12, Michigan.

Sept. 19-21—Yankton, S. Dak. *(Charles Gurney Hotel)*
SOUTH DAKOTA SECTION A.W.W.A. (Joint Meeting)
SOUTH DAKOTA SEWAGE WORKS ASSOCIATION. Sec'y, Chas. E. Carl, State Board of Health, Pierre, S. Dak.

Sept. 24-25—Denver, Colo. *(Cosmopolitan Hotel)*
ROCKY MOUNTAIN SECTION A.W.W.A. Sec'y, Geo. J. Turre, P.O. Box 600, Denver, Colo.

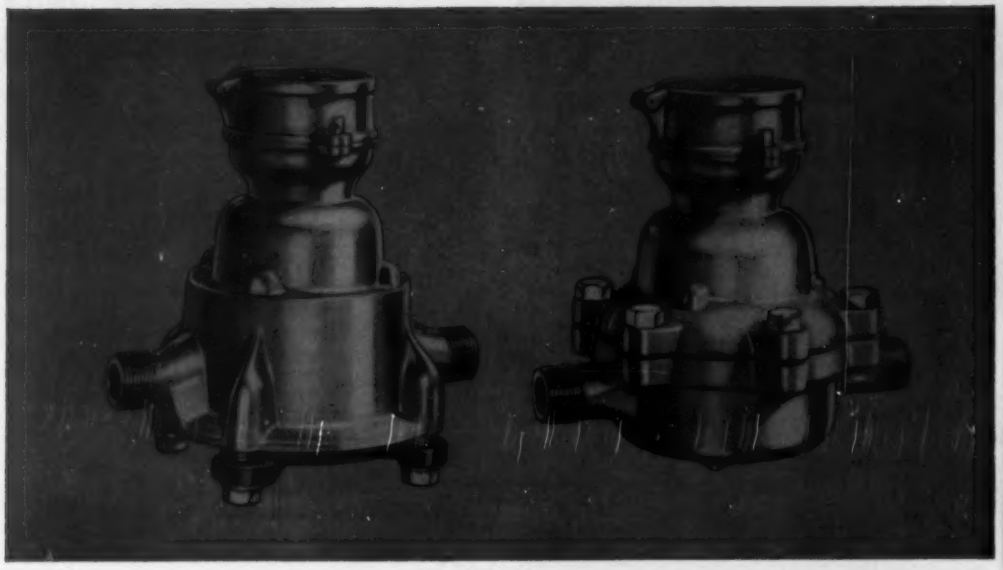
Sept. 25—
ROCKY MOUNTAIN SEWAGE WORKS ASSOCIATION. Sec'y, Carrol H. Coberly, 1441 Welton St., Denver, Colo.

Sept. 24-26—Biloxi, Miss.
ALABAMA-MISSISSIPPI SECTION A.W.W.A. Sec'y, Chas. W. White, 519 Dexter Ave., Montgomery, Ala.

Sept. 25-27—Milwaukee, Wis. *(Hotel Pfister)*
WISCONSIN SECTION A.W.W.A. Sec'y, Leon A. Smith, City Hall, Madison 3, Wis.

Oct. 8-11—St. Paul, Minn. *(Municipal Auditorium)*
FEDERATION OF SEWAGE & INDUSTRIAL WASTES ASS'NS. (Annual Convention) W. H. Wisely, 325 Illinois Building, Champaign, Ill.

Badger Stands for more than Meters



Badger means complete meter Service

Yes, you'll find every type and size of meters in the complete Badger line . . . but you get *more than meters* from Badger. You get complete meter service: ● Dependable recommendations for every water-measuring need . . . Badger-engineered and precision-built mechanical features that assure you full revenue by unfailingly recording every drop of water used . . . rugged quality that means maximum service life, minimum maintenance, lowest year-in and year-out water-metering costs ● You get successful Badger background of nearly half a century . . . meter installation and servicing counsel . . . meter-reading features that save time and money . . . efficient Badger Meter Testing Machines, and many Badger-engineered exclusive advantages ● For complete meter service, you'll find it pays to contact Badger.

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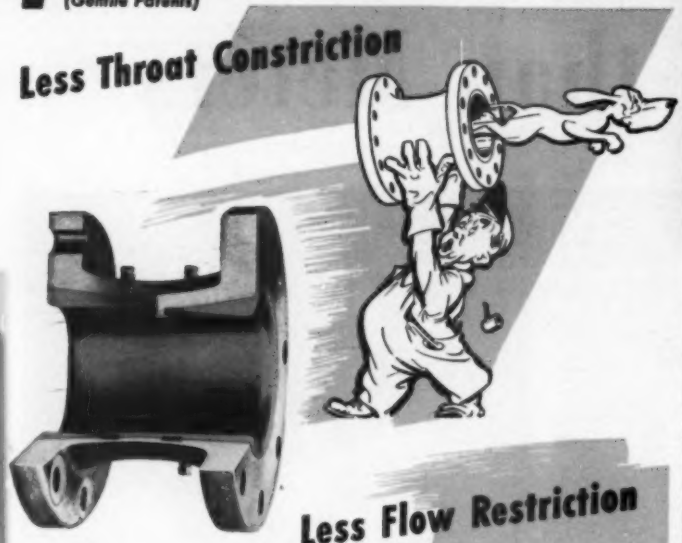
FOSTER FLOW TUBE*

(Gentile Patents)



Study the above picture of the Foster Type V Flow Tube which operates on the viscous drag principle. Note the almost straight-through construction. There's only a slight throat constriction. And the same minimum throat constriction is typical of the Type D Flow Tube which operates on the principle of dynamic impact. *Both types offer minimum resistance to flow.*

You know what this means. Negligible unrecovered head loss in the flow of the liquid or gas. Less power required to push it along.

"Cood," you say, "but what about accuracy?"

The Foster Flow Tube will measure the flow of liquids or gases with an accuracy at least comparable to that of conventional primary devices and, in most cases, with considerably greater accuracy, because it can readily be installed in that section of the hydraulic system where flow conditions are uniform and steady. Thus, with this unique Flow Tube, you can combine accuracy with neglible head losses—accuracy with compactness—accuracy with ease of installation.

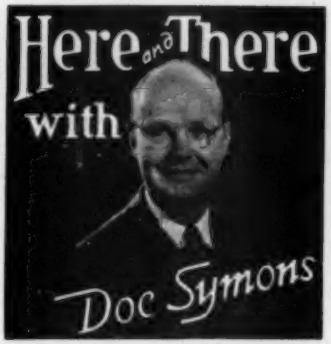
Write us in detail about your problem, giving both processing and installation requirements. We have several types and units in all commercial pipe sizes.

*A Proved Flow Tube Added to Foster Line of Regulating Valves

FOSTER ENGINEERING Company

835 Lehigh Avenue • Union, N. J.

PRESSURE REGULATORS...RELIEF AND BACK PRESSURE VALVES...CUSHION CHECK VALVES...ALTITUDE VALVES...RATIO [illegible] REGULATORS...PUMP GOVERNORS...TEMPERATURE REGULATORS...FLOAT AND LEVER BALANCED VALVES... [illegible] VALVES...VACUUM REGULATORS OR BREAKERS...STRAINERS...SIGHTS...SAFETY VALVES...FLOW TUBES



H.T.M.A.—And on this dark and snowy Sunday, I've been thinking—Oh, nothing profound, just musing—about how long I've been writing this column, about how long it takes to write one, and about what I would write this time.

* * *

I remember early in 1944 talking to A M (without periods) Rawn, who was then guiding the destinies of sewage works through WPB. We could use him now, again, it seems, but he's masterminding the Los Angeles County Sanitary District—But to get back to early 1944; A M told me about, how, after five years he gave up writing a monthly column for *Western Construction News* (I believe).

Then, I had been writing this column for a scant few months—Five years of columns???—It was a long way off, and by that time, I would probably have run out of ideas—But I reckoned without the egocentric satisfaction of the fulfillment of a small boy's ambition to write a column; a desire that had gradually, by press of earning a living, diminished to the hobby of letter writing.

What frustrated ham actor would turn down the opportunity to appear before a public at regular intervals—and besides it gave me a chance to indulge my letter writing hobby regularly and to make one letter reach hundreds of friends, instead of but a few.—So here I am writing my 91st letter to you—and it looks now, as though I can make it a hundred if you folks keep sending in stories.

* * *

What's In A Name?—Do you remember in the December issue, when I ran the story from W. F. Schaphorst about Mrs. Schreitmueller and Mrs. Dutcher—Well, two days after that column appeared, I received the following letter from DeWayne Dutcher, Operator of the Sewage

(*Continued on page* 94A)

Streamway POWER FOR PUMPS

WITH THE NEW VERTICLOSED

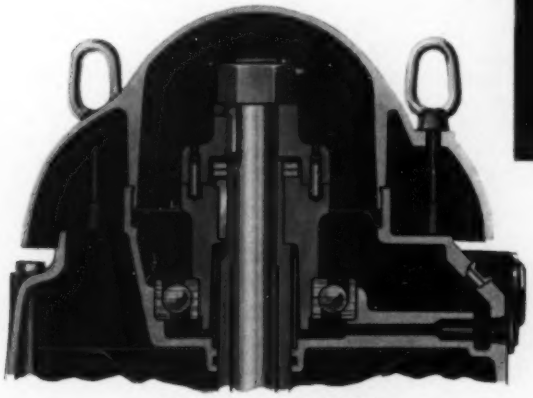
U. S. MOTOR

This amazing new motor involves much more than attractive external appearance. It introduces an entirely new conception of pump motor refinements. The deep well pump you select and its U. S. Verticlosed Motor become fully integrated both in structure and function.

The Verticlosed Motor is the progressive result of designing a motive unit for a specific purpose—to *most economically* power a deep well turbine pump.

You can order this new motor as an integral part of your new pump without paying increased price. Or you can replace your present pump motor without paying for expensive fittings.

Whatever pump you choose, specify the U. S. Verticlosed Motor. You'll save on power; you'll benefit by real economy through many years of extra pump life.



Detail showing Reg-U-Lube Oil Flow

Improved lubrication with

REG-U-LUBE and LUBRIFLUSH systems

Because pump motors must continuously operate for long periods under heavy load, lubrication must be positive—never failing. In the larger size Verticlosed Motors the proven Reg-U-Lube system provides a gravity-fed oil flow which keeps bearing lubricant at normal temperature. In Verticlosed Motors of under 25 h.p., 1800 rpm, the perfected Lubriflush system permits thorough flushing of old devitalized grease.

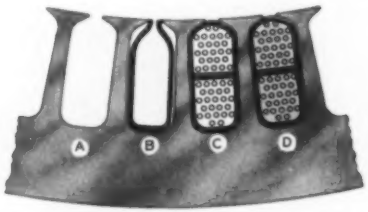
AMERICA'S MOST DYNAMIC PUMP MOTOR

(See next page)

THESE ADVANCED U. S. MOTOR FEATURES INCREASE THE LIFE AND SERVICE OF DEEP WELL PUMPS

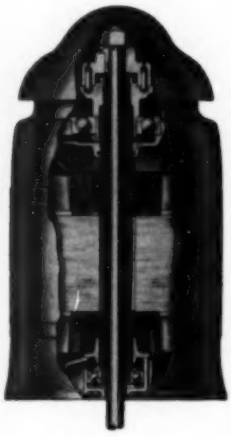
To give the maximum service, a deep well turbine pump must be powered by a motor free from vibration, free from excessive bearing stresses, ever-cool during long periods of continuous operation, and high in efficiency. The new U. S. Verticlosed Motor meets and exceeds these requirements. Moreover it offers many advanced features found in no other motor because it has been designed for one specific service—the powering of deep well turbine pumps. More than forty years of constant progress are reflected in its incomparable design.

U. S. Vis-O-Lube Oil Gauge



ASBESTOS-PROTECTED WINDINGS

Asbestos *cannot* carbonize. It safeguards U. S. motor windings from internal heat. The above drawing shows method of application. *(A)* Empty stator slot. *(B)* Insulating sheet asbestos. *(C)* Conducting wires in asbestos cell. *(D)* Complete asbestos impregnation around each wire.



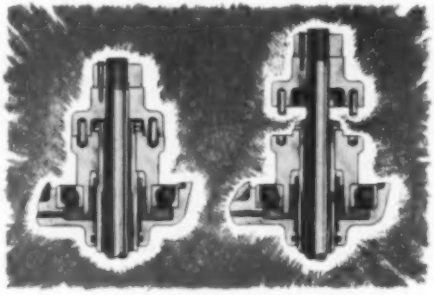
Showing the hollowshaft principle conceived and patented by U. S. Motors. The flexible coupling is eliminated, and pump head thrust bearings relocated in the motor.

FULLY VISIBLE OIL GAUGES

No more unsightly, protruding oil gauges. The new U. S. Vis-O-Lube gauges are set within the motor, fully visible at a distance. Large, clear Lucite windows reveal oil content.

NORMALIZED CASTINGS

Fine precision parts such as used in giant telescopes, artillery guns, angle blocks, etc., are invariably *normalized*, to prevent warpage and stresses. So are U. S. motor castings; therefore bearings are always in perfect alignment, insuring longest life.



REVERSE PROTECTION CLUTCH

By using the famous U. S. hollowshaft, the pump shaft is connected with the motor shaft through this reverse protection clutch. The pump shaft cannot become unscrewed by torque reversal.

Whatever the pump, make U. S. Motor a "must"

The leading deep well turbine pump manufacturers of America long ago accepted U. S. Motors as the most outstanding and dependable power for this specific service. Many pump builders have designed their pumps to synchronize with the streamlined beauty of the new and improved U. S. Verticlosed Motor. Be sure you get a U. S. Motor. Accept no substitute.

Write today for descriptive, illustrated Bulletin

The* QUALITY LINE *of Power

ELECTRIC MOTORS TO FIT THE NEED

VARIDRIVE — SYNCROGEAR — VERTICLOSED — UNICLOSED— UNIMOUNT AND TOTALLY-ENCLOSED

Request Bulletin featuring any of these motors

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U.S. MOTORS

ASBESTOS PROTECTED
NORMALIZED CASTINGS
LUBRIPLUSH LUBRICATION

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WATER & SEWAGE WORKS READER SERVICE

READER SERVICE CARDS HOW TO USE THEM

Please fill out a separate coupon for each item on which you desire information. This will greatly facilitate handling.

Key number is at head of each new product, item of equipment, catalog or bulletin, described in this issue.

Enter key number in box.

Please PRINT your name and title, company or department name, and your address

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WATER & SEWAGE WORKS

Will see that you receive information desired.

WATER LEVEL CONTROL

Never Sleeps
Never Forgets

Maintains exact levels to 1/100 of an inch in **Water Tanks—Reservoirs—Settling Basins—Boilers—**

Lumenite Electronic **LIQUID LEVEL CONTROL**

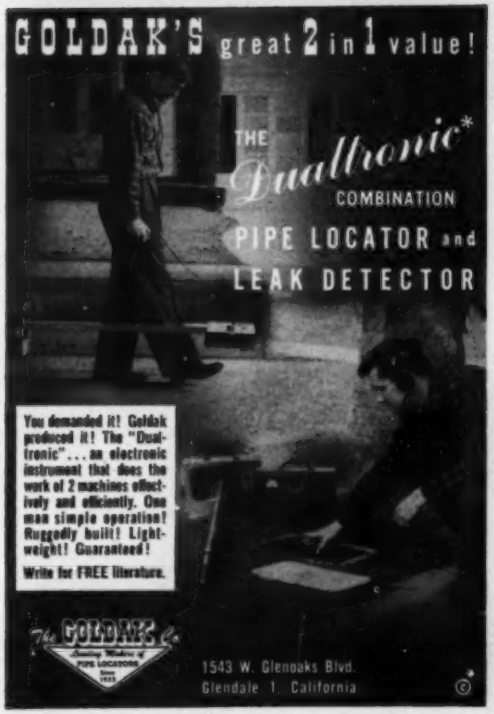
To Pump Motor, Motorized Valves, Solenoid Valves, Etc.

Has **no moving parts**—no **floats**—Operates electronically with 1/10000 Amp. impulse. Just two steel rods in container—nothing else. Controls directly pump motors, motorized valves. Simple installation. Practically no up-keep.

Write for Engineering bulletin No. 421

Lumenite Electronic Company
ENGINEERS DESIGNERS MANUFACTURERS
407 S. Dearborn Street Chicago 5, Ill

GOLDAK'S great **2** in **1** value!



You demanded it! Goldak produced it! The "Dualtronic"... an electronic instrument that does the work of 2 machines effectively and efficiently. One man simple operation! Ruggedly built! Lightweight! Guaranteed!

Write for FREE literature.

The GOLDAK Co.
Pioneer Builders of PIPE LOCATORS Since 1935

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FERRIC SULPHATE

Residual Iron

All iron in FERRI-FLOC is already in the ferric state and there can be no danger of residual iron passing into the distribution system. Any iron floc that is not removed in the basin is readily removed on the filters. FERRI-FLOC is not an iron remover but users of FERRI-FLOC have found that none of the iron in FERRI-FLOC will pass through the filters. This is just one of the many advantages that FERRI-FLOC offers.

SULPHUR-DIOXIDE

HIGHEST QUALITY

SO_2

Sulphur Dioxide is effectively used in water treatment to remove objectionable odors remaining after purification.

FREE BOOKLET

A postal card or letter will bring you our booklet on the advantages of FERRI-FLOC — Tennessee Corporation, Grant Building, Atlanta, Georgia, or Lockland, Ohio.

TENNESSEE CORPORATION

(*Continued from page 90A*)

Treatment Plant of Tomah, the Parkway City of Wisconsin—

"Dear Doc—Now, you look here Doc Symons. We Dutchers are proud of the Irish origin of our name and you go bandying it about as if it could be more Dutch than Schreitmueller.—I have known a lot of Dutcher's (some related, some not) and all that I have ever met are of Irish descent. In fact, the first Queen of the Irish Free State was a Dutcher before her marriage.

"At one time I thought it would be great sport to trace down my family tree, and every time I met up with the name Dutcher, I tried to trace it back to Ireland. Well—once when I was in So. Dakota, I heard some one mention the name so I set to work as usual—only it turned out that that Dutcher was wanted for stealing horses. Since then I haven't traced any more branches of the family tree. —Yours very truly, DeWayne Dutcher.—P.S. the horse thief was NOT Irish."

* * *

Not every one gets queried by an inquiring photographer of some newspaper, but down at the Federation Meeting in Washington the Times Herald's "Inquiring Fotographer" cornered six fellows attending the sessions and asked them "Did you ever bring a guest home to dinner without telling your wife?" Among those so queried were: John M. Veasey of R. B. Carter Co., Hackensack, N.J.; Maxwell Daviss, Deputy Engineer of the Birmingham, England Sewage Works; R. G. Calihan, Acting Supt., Sewage Treatment Plant, Dayton, Ohio; John O. Barrett, Cleveland, Ohio, Supt. of Westerly Plant; O. F. DePue, Adv. Mgr., Newton, N.J.; and C. E. Lindberg, Adv. Div. Gen. Elect. (Disposall) Bridgeport, Conn. Two said they were not guilty; two said they were only guilty once or twice, and two said their wives never objected to the practice. I'm turning a copy of the column, as it appeared, over to Homer Wisely, Fed. Secy. for his scrap book, in case any of you six didn't see it.

* * *

Some weeks ago, Mr. Farley Gannett, Pres. of Gannett, Fleming, Corddry, and Carpenter, Cons. Engrs., Harrisburg, Pa., remonstrated with Linn Enslow (Ye Ed of this magazine) for espousing the cause of Fluoridation of Water. Enslow wrote a forthright reply stating his case, and Mr. Gannett conceded the logic of the argument.—A week or so later he went even further as indicated by this letter which I begged from Enslow for use in my column. Here 'tis—

"My dear Enslow:—This is in further regard to yours of Nov. 24 regarding the use of fluorides in water supplies, and after more consideration and discussion with my engineering mentor and Vice President, Howard Corddry.

"We started by suggesting other things that also might be added to water to promote demand and thus increase sales, and after adding fluorides for the teeth, iodine for goiter, lime for the bones, we arrived at sex hormones. This would not only create immediate and extensive demand but by increasing the population would further promote the use of water.

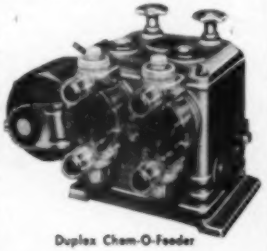
"Then looking further, if we cure all ills by injecting medicines into water supplies, the doctors would go out of business altogether [except obstetricians], investments in hospitals would be wasted, as they would stand idle unless we resorted to war to create a need for doctors and hospitals again, and then the war would be blamed on the water supply.—I'll let you carry on from here. Sincerely and honestly, Farley."

I wish I could let it stand right there as a very amusing item, but I

(*Continued on page 96A*)

When you need pure, potable water in a hurry you can't beat %Proportioneers% Pur-O-Pumper! Construction crews, civilians, and the armed forces count on %Proportioneers% for clear, safe water wherever they work or fight. The Pur-O-Pumper is a triple-duty unit — (1) it pumps its own water supply from any stream or pond, (2) it sterilizes every gallon in proportion to flow, and (3) it filters the water through a highly efficient, diatomaceous earth filter. In peace or war, the Pur-O-Pumper is ready for service — it is entirely self-contained, easily portable . . . easy to set up wherever required.

The heart of the Pur-O-Pumper is %Proportioneers% Duplex Chem-O-Feeder, proven in thousands of installations for general purpose feeding. It feeds hypochlorite solution for sterilization and slurry for body coating the Pur-O-Cel Diatomaceous Earth Filter. The Pur-O-Pumper incorporates %Proportioneers% famous Pur-O-Cel Filter that has long been used in leading bottling plants and swim pools, and is now being used in municipal water plants.



Duplex Chem-O-Feeder

Be ready for any emergency — write today for information.

% PROPORTIONEERS, INC. %

358 HARRIS AVE., PROVIDENCE 1, R. I.

A city selects "Century"® Asbestos-Cement Pipe after "in use" tests

Before you buy or specify any pipe for water mains, consider the experience of a large city in the southwest:

Because of deterioration from electrolysis and lowered efficiency from tuberculation, original installations of pipe needed replacement after only six years' service. Special test installations of "Century" Asbestos-Cement Pipe—supervised by city water officials—proved: "Century" Pipe is not affected by tuberculation; it resists both electrolysis and soil corrosion. Result: Many thousands of feet of Asbestos-Cement Pipe have been laid under the streets of this city and its suburbs as replacements and extensions for the system.

Consider also the other features of "Century" Pipe: It's exceptionally strong, yet light in weight; can be handled easily, laid quickly without special laying equipment. "Century" Simplex Couplings permit rapid, easy laying of both straight runs and curves up to 5° deflection per pipe length. And "Century" Pipe can be recovered and relaid in its original pressure class!

If you have difficult or unusual conditions that may affect the service of your water mains, get complete information on Keasbey & Mattison "Century" Asbestos-Cement Pipe. We'll gladly send details upon request.

Nature made Asbestos . . .
Keasbey & Mattison has made it serve mankind since 1873

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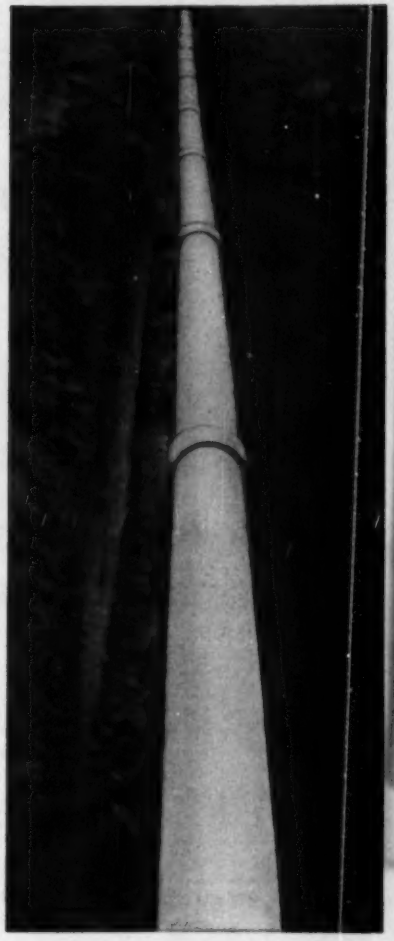


"Century" Pipe is made in two pressure classes: 100 and 150 pounds per square inch. Every section is hydrostatically tested to insure ample reserve to handle normal "water hammer" and possible pressure increases.

"Century" Pipe is made in accordance with and conforms to U. S. Federal Specifications SS-P-351, which recognizes this pipe as suitable for purchase by all U. S. Government agencies.

(*Continued from page 94A*)

fear that I must say for the benefit of the readers of the thirty or so copies of this magazine which go to Russia and her satellites, MR. GANNETT IS NOT A WARMONGER.—That letter is strictly a joke and don't let me hear any nonsense to the contrary by Pravda or any other of your masters of distortion, and downright deliberate lying.

* * *

Following my November column, when I mentioned that I was on a diet of baked potatoes and T-Bone steak (for two, preferred), I received the following letter from James G. Griffiths, Supt. and Manager of the Water System of New Kensington, Pa., who wrote—

"Dear Doc—Your diet of baked potatoes is O.K. but you'd better cut down on that steak. I was always a man after your own idea but I woke up one day with diabetes and you should see my diet now. Good food having been my hobby, and now denied me, I don't take well to you bragging about your wonderful diet. Sincerely, Jim."

WANTED—A Caption for This Picture.

Of course, you know that the above is Ralph E. Fuhrman, Supt. of Sewage Treatment in the Nation's Capital and currently President of The Federation S&IWA.—Photo Courtesy of the Oklahoma Water And Sewage Conference.

* * *

At the N.Y. Section meeting in New York in January, Jim (Neptune Meter) Whelan, of Long Island was on the registration desk again.—He must be good, they always ask him back every year to do the job. Anyway, Jim said to me, "Doc, What does that HTMA stand for at the beginning of each of your columns?"—I told him it was "Here's That Man Again"—I guess he had missed it when I had spelled it out in several issues.

* * *

At that same N.Y. Section meeting, most of the AWWA Board was there. It was good to see them all. I had a chance to exchange a few words with Cliff Fore of Southern Illinois; my fellow Council Bluffer, Wendell (Akron, O.) La Due, and Vic Weir (AWWA Prexy) who had just bought the water works in Gary, Ind.

* * *

Several years ago, when I was just beginning to write this column I came out flat flooted with my hurrah when the Ohio Section proposed that Wendell La Due be elected Vice Pres. of the AWWA and a couple of years later he was. Some kind reader pointed out that it might be embarrassing if I ever did that again, even if it was a personal opinion and had nothing to do with the editorial policy of the magazine. So I never again mentioned potential candidates for that high office, but a good many of my private choices have been tapped for the honor—and that includes the latest,—"Charlie" (Wanaque, N.J.) Capen.

BUILDERS *Chlorinizer* WORKS AT THE AMERICAN SCREW COMPANY

MODEL CVS

Here at the Willimantic, Conn., plant of the American Screw Company, Builders Visible Flow Chlorinizer is handling a tough job — and doing it well! The Chlorinizer feeds chlorine gas at the exact rate required for the treatment of cyanide wastes. As in many other industrial waste treatment plants throughout the country, this dependable chlorine gas feeder has been selected for its safety, accuracy, and reliability.

Builders Chlorinizer is available in three popular models to suit every chlorination need. For complete information and descriptive Bulletins, address Builders-Providence, Inc. (Division of Builders Iron Foundry), 350 Harris Avenue, Providence 1, R. I.

BUILDERS PRODUCTS

The Venturi Meter • Propelofio and Orifice Meters • Kennison Nozzles • Venturi Filter Controllers and Gauges • Conveyoflo Meters • Type M and Flo-Watch Instruments • Wheeler Filter Bottoms • Master Controllers • Chlorinizers — Chlorine Gas Feeders • Filter Operating Tables Manometers • Chronoflo Telemeters

BIF INDUSTRIES **BUILDERS-PROVIDENCE** BUILDERS

FOR MORE EFFICIENT *Sludge Digestion*

The Indicating *ElectroniK* Potentiometer. Permits push-button contact with important temperatures in all of the plant's digesters... up to 48 points from one central location.

The Brown 3-Pen Recording Thermometer. Keeps an accurate record of individual digesters' three important temperatures... (1) Sludge, (2) Hot Water-In, (3) Hot Water-Out.

USE the Brown Recording Thermometer to get an accurate and continuous "picture" of conditions in a single digester. Use the *ElectroniK* "Push-Button" Indicator to check temperatures of a group of digesters . . . without walking around the plant. Choose the system that suits your need!

You'll *know* if sludge temperature is being maintained for proper rate of digestion. And you'll know, too, from the temperature differential between water to and from the digesters, how well the heat is being absorbed by the sludge. You'll have guides to efficiency . . . and you'll be warned of incrustation on the heating coils.

Such efficiency pays off in dollars and cents savings. Call in your local Honeywell engineer for detailed information . . . he is as near as your phone. Write today for a copy of Bulletin 7301.

MINNEAPOLIS - HONEYWELL REGULATOR Co., *Industrial Division*, 4575 Wayne Ave., Philadelphia 44, Pa. Offices in more than 80 principal cities of the United States, Canada and throughout the world.

MINNEAPOLIS **Honeywell**

BROWN INSTRUMENTS

Small World No. 13—When Linn and Mary Elva Enslow went to the Florida-Cuba Section meeting last fall, they naturally stopped off at the Dr. A. P. Black's home in Gainesville. Naturally, too, they had dinner at the Gainesville Country Club.

In some manner, Linn got to talking to the manager of the Club, who, when he learned of Linn's interest in the water and sewage works field, asked, "Do you know a fellow by the name of George Symons from Danville, Ill.?"—Whereupon, Doc Black spoke up—"You're talking to his boss!"—Gelwick and I went to high school together.—Small world!

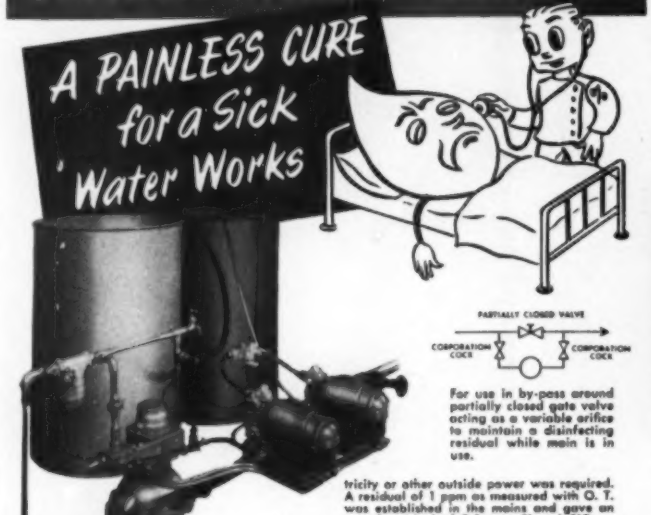
* * *

Well now—let's see—Here it is the end of another "letter" and there are so many things I haven't told you—There's another water works romance (from Connecticut, this time), there's the picture of several members of the AWWA Wisconsin Beanie Club, several more stories about the Federation meeting in Washington, including one about Don Bloodgood and, and, and—So long for a spell—

V.T.Y.—Doc.

CHLORINE DIOXIDE TREATMENT

A PAINLESS CURE for a Sick Water Works



For use in by-pass around partially closed gate valve acting as a variable orifice to maintain a disinfecting residual while main is in use.

Discovery of contamination in the mains was mighty disturbing to a certain New England town of 15,000 people, extremely proud of its pure water supply. But the cure was simple and sure — %Proportioneers% Chlorine Dioxide System in ten days entirely eliminated the contamination while the mains were in use. In addition, the chlorine dioxide "saved face" for the water works since the treatment was completed virtually unbeknown to the water users.

TREATMENT: %Proportioneers% hydraulically operated Chem-O-Feeder, complete with Chlorine Dioxide Generator, was easily installed as shown in the diagram. No electricity or other outside power was required. A residual of 1 ppm as measured with O. T. was established in the mains and gave an actual residual of 2.3 ppm Cl and ClO_2 — without noticeable taste or odor. After 10 days, tests proved the sterilization complete, and the treatment was discontinued.

TODAY, in peace or war, pure water is a "must"! Every water works needs this emergency sterilization equipment. %Proportioneers% Chlorine Dioxide System is the ideal unit . . . it's complete, ready for instant use: to sterilize new mains, to eliminate contamination, to meet the emergencies of war. Investigate now, while equipment is still available. Write for bulletins.

%Proportioneers, Inc.% 350 Harris Ave., Providence 1, Rhode Island.

% PROPORTIONEERS, INC. %

Manufacturers' and Equipment News

Multi-Stage Centrifugal Pumps

301

Ingersoll-Rand Co., Phillipsburg, N.J., has announced a line of new multi-stage centrifugal pumps for high-pressure applications to 1200 psi. and capacities to 1600 gpm. Known as class HMTA, they are built in 3, 4, 5 and 6 inch sizes with from 3 to 9 stages.

The features of this new design are its cylindrical-bore, horizontally-split casing and compact, Unit-type rotor assembly. The rotor assembly is composed of the shaft, impellers, and channel rings. These channel ring sections contain the multiple volutes and fluid passages, as well as the renewable wearing parts for each stage.

Mueller's "Bill" Simpson Dies

J. W. (Bill) Simpson, who advanced from errand boy to executive vice-president of Mueller Co. of Decatur, Ill. died suddenly at work early this year. Only a year ago, this magazine carried the story of how "Bill" Simpson had received a diamond studded fifty year emblem at ceremonies of the company honoring long-time service.

Mr. Simpson, who began work for the company in 1899, had just been elected executive vice president for the fifth year, the day before his death; he was only 67 years old at the time. Mr. Simpson was well known to the water works industry and his passing will be a shock to many friends throughout the country as well as a great loss to the company which he served so well and so long.

U. S. Pipe Elects Semple

United States Pipe and Foundry Co., Burlington, N.J., has announced

(*Continued on page* 100A)

If interested in equipment or literature mentioned above, mail a Reader Service Card with your name, address, and item key number.

"FLEXIBLE"

UNDERGROUND PIPE CLEANING CO. SEWER-ROD EQUIPMENT CO.
9059 VENICE BOULEVARD, LOS ANGELES 34, CALIFORNIA

141 W. Jackson Blvd. Chicago, Ill. | Francis Hankin Montreal & Toronto, Canada | 147 Hillside Ter. Irving, N. J. | P. O. Box 165 Atlanta, Ga. | P. O. Box 465 Memphis, Tenn. | 801 E. Excelsoir Blvd. Hopkins, Minn. | 29 Cordon Ave. Roslindale 31, Mass.
P. O. Box 167 Los Nietos, Calif. | 41 Greenway St. Hamden, Conn. | 3786 Durango Ave. Los Angeles 34, Calif. | 709 House Bldg. Pittsburgh 22, Pa. | 4455 S. E. 24th Ave. Portland 2, Ore. | 351 W. Jefferson Blvd. Dallas, Texas

THE SILENT WATCHMAN

DIXIE TANK AND BRIDGE CO.

3523 LAMAR AVE. P. O. BOX 14
MEMPHIS 1, TENNESSEE

Complete Service for Elevated Water Tanks—
Nation Wide Service—30 Years Experience

KEEP THE SAFETY FACTOR IN
YOUR TANK THE DIXIE WAY

By welding seams, pits and rivets which gives a riveted tank 15% more Safety Factor than it had when built. No rivets removed, water supply maintained while work is in progress. On completely reconditioned jobs, the painting is guaranteed for five years, repairs guaranteed for ten years, provided the tank is painted every five years by Dixie Tank and Bridge Company. Yearly inspection, making all adjustments, if any, without additional cost.

Write Us for Free Copy of Publication

SOUND PRINCIPLES OF WATER TANK MAINTENANCE and TANK TALK, by W. A. RILEY

—SAFETY—SERVICE—SATISFACTION—

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THE LARGEST ORGANIZATION OF ITS KIND GIVING SAFE MAINTENANCE AT LOW COST

(Continued from page 98A)

the election of Lorenzo Semple as vice president and treasurer.

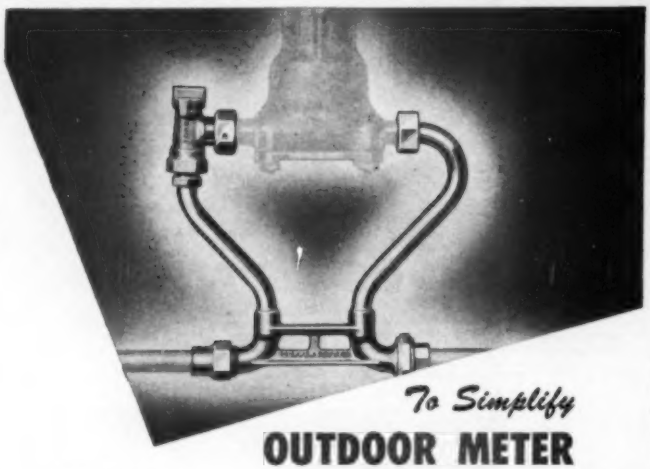
Semple was graduated from the U. S. Naval Academy in 1921 and resigned his commission in 1924. After brief periods with RCA and Brooklyn Edison, he joined the American Water Works and Electric Co. in 1926 and was associated with it until 1948, at which time he was vice president. During that period he acquired extensive experience in engineering, finance and general executive management of both water and electric utilities. More recently he has been engaged in the manufacturing industry and as consultant to the Belgian Congo.

"Ollie" DeCelle Now Director of Sales and Advertising for B. F. Gump Co.

Oliver A. DeCelle has been appointed Director of Sales and Advertising of B. F. Gump Co., Chicago, manufacturers of chemical feeders, weighers, grinding and packaging equipment.

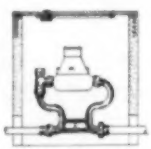
Ever since graduation, as Chemical Engineer from Illinois Institute of Technology in 1914, DeCelle has been with Infilco Inc. Starting as design engineer under the late Walter H. Green, he subsequently became sales engineer, New York district manager, then advertising and sales manager.

At the time of his resignation, when Infilco transferred its general offices from Chicago to Tuscon, Ariz. last fall, he was executive vice-president of the company.



To Simplify

OUTDOOR METER SETTINGS



With a Ford Coppersetter, or a Ford Linesetter, you can eliminate as many as six pipe joints, two risers, four ells, one pipe coupling, one meter coupling and possibly a valve. In so doing, you raise your meter from 3" to 36" above your service line, depending upon the model used. Positive alignment is maintained when meters are changed.

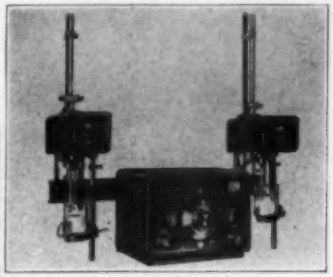
Copper and bronze construction add extra years of life. Hydraulic efficiency is improved.

The economy is obvious . . . . and the savings are real. Send for free catalog. It contains complete information.

FORD

FOR BETTER WATER SERVICES

THE FORD METER BOX COMPANY, INC. Wabash, Indiana



Automatic Titrator

302

Beckman Instruments, Inc., South Pasadena, Calif., has announced the Beckman Automatic Titrator which handles routine titrations completely automatically. According to the company, the Beckman Automatic Titrator not only makes accurate titrations more rapidly and conveniently than is possible by manual methods, but it also gives objective, reproducible results that are free of errors due to personal factors.

The operation of the titrator is simple and convenient. In a series of titrations it is only necessary to fill the burette, place the sample in the beaker and then turn the rest of the operation over to the titrator. Raising the beaker holder into position automatically starts the stirrer motor and begins delivering titrating solution into the sample.

A noteworthy feature is the unique circuit employed that electrically anticipates the approaching end point, scaling down delivery of the titrating solution in progressively smaller increments to assure a highly accurate titration. When the end point is reached, delivery of the titrating solution automatically stops and a light shows completion of the titration.

Neptune Meter Pays Out More in Dividends

Neptune Meter Co. has voted its first dividend on the new stock of the Company. The new common stock resulted from a split of two shares for each share of the old stock, which was paying $2.00 per year.

If interested in equipment or literature mentioned above, mail a Reader Service Card with your name, address, and item key number.

The first dividend to holders of record on Feb. 2nd indicates a rate equivalent to $3.00 per share per year on the old stock if the quarterly payment of 37½ cents per share on the new common continues.

Verako Products Appoints Walter Skyrius Sales Manager

Walter M. Skyrius, for 16 years sales representative in Wisconsin, Iowa, and Northern Illinois for Johns-Manville Sales Corp., has joined Verako Products Inc., of Waukegan, Ill., as Sales Manager.

This announcement has just been made by John Verakas, president of Verako Products, which serves as Manufacturers Agents for a number of well known products and materials used in the water and sewage field, including the novel non-corrodible Shock-Proof Curb and Valve Boxes developed in the Milwaukee Water Department.

Flexible Power Motor

303

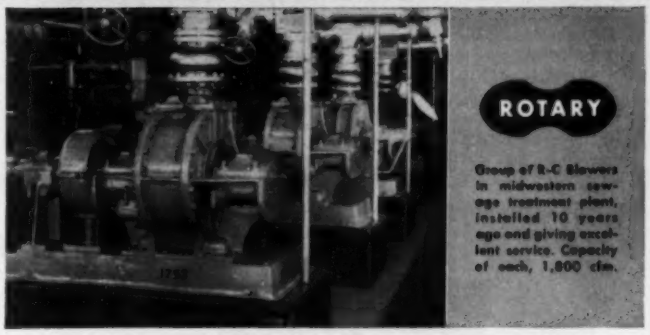
Electric Machinery Mfg. Co., Minneapolis, Minn., announces a new line of Heavy-Duty, Wound-Rotor Induction Motors. These motors provide variable speed drive, and are also advantageous on applications requiring high starting torque and low starting current, or long acceleration periods.

Built in ratings from 30 to 1500 hp., drip-proof construction is furnished as standard on these motors. Splash-proof or enclosed, forced-ventilation models are also available. The heavy-duty, fabricated steel frame features high physical impact strength and crack-proof steel-bar feet. The motors are available with either ball or split-sleeve type bearings and are easily accessible for inspection and maintenance.

Worthington Completes Reclamation Station

Worthington Pump & Machinery Corp., Harrison, N.J., delivered the sixth 22,500 hp. centrifugal pump to

NO V·P·I WORRIES WITH R·C BLOWERS



ROTARY

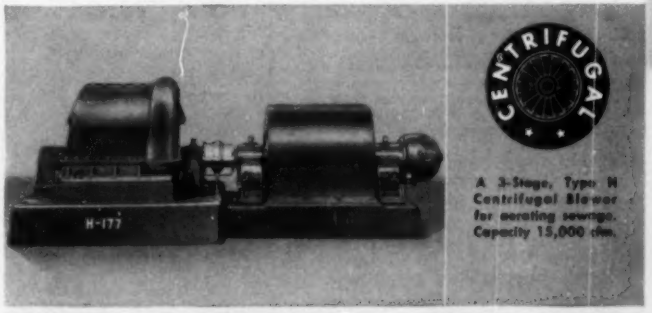
Group of R-C Blowers in midwestern sewage treatment plant, installed 10 years ago and giving excellent service. Capacity of each, 1,800 cfm.

Continuous separation processes in modern sewage treatment depend upon adequate performance of blowers. You can be sure of positive Volume, at the required Pressure and at Low power cost when Roots-Connersville Blowers move the air.

You can obtain this freedom from worry by selecting either R-C Centrifugal or Rotary Positive equipment from our exclusive *dual-ability line.* For large municipal plants, R-C units deliver up to 100,000 cfm. For industrial waste treatment, using small blowers, we supply Rotary Positive units with volume as low as 5 cfm. This wide latitude permits use of blowers closely matched to demand, with resultant economy in first cost and in power consumption.

The services of R-C engineers are always available to help select the best equipment for the sewage treatment job to be done.

ROOTS-CONNERSVILLE BLOWER CORPORATION
510 Mount Avenue, Connersville, Indiana



CENTRIFUGAL

A 3-Stage, Type H Centrifugal Blower for aerating sewage. Capacity 15,000 cfm.

ROOTS-CONNERSVILLE

BLOWER BUILDERS SINCE 1854

ONE OF THE DRESSER INDUSTRIES

complete the company's contract with the C. S. Bureau of Reclamation project at Tracy, Calif.

The pumps will lift water 200 feet from the Sacramento River, sending it into the 120-mile Delta Mendeta Canal to irrigate farms in the San Joaquin Valley.

Each pump is rated at 767 cubic feet per second at a 200-foot pumping head. The completed plant will be able to pump nearly three billion gpd.

To house these pumps, the world's second largest pumping plant had to be constructed at Tracy in an excavation larger than Boulder Dam. The project was started in October, 1947, and it is expected that some units will commence operation the first part of 1951.

Leeds & Northrup Expands

Leeds & Northrup Co., Philadelphia, Pa., has announced the acquisition of approximately 85,000 square feet of additional floor space. This space will allow increased production and improved delivery and other service facilities. Some operations will be transferred to this new space, but the principal manufacturing and other activities of the firm will continue to be centered at the main plant, 4901 Stenton Avenue.

The added space is a 3-story, 50,000 square foot building at Castor and Sedgley Avenues and 35,000 square feet at Collum and Tubicam Streets, Germantown.

For ECONOMICAL, LONG-LASTING PROTECTION of Equipment and Property

You'll find Pitt Chem Cold Applied Tar Base Coatings ideal for a wide variety of protective jobs. Made from coal tar pitch, one of nature's most impervious protective materials, they're easy to apply, relatively low in cost, and effective against most corrosion conditions.

The uniform top quality of Pitt Chem Cold Applied Tar Base Coatings is assured by the close production control which results from our completely integrated manufacturing operation. If you're looking for an economical, dependable way to add years of service to your plant's physical assets, see your nearest Pitt Chem man . . . or write for new booklet, "Control Corrosion through Pitt Chem Protective Coatings".

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Industry's Most Comprehensive family of Protective Coatings

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- ★ Chlorinated Rubber Base Coatings—Series 300
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PROTECTIVE COATINGS DIVISION

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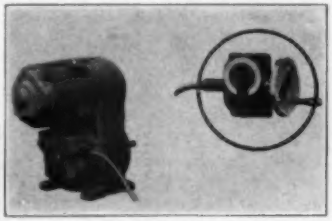


Remote Control for Electric Drives

304

Sterling Electric Motors, Inc., Los Angeles, Calif., has announced the development of a new improved mechanical Remote Control for Sterling Speed-Trol (variable speed) electric power drives. This control is designed so that it can be adapted to any Speed-Trol now in use.

This remote control is available in a variety of types, such as with extended flexible cable, or with an extended rod with universal joint, right angle bevel gear with extended rod, chain and sprocket, or a combination of any or all of the above. A remotely located speed indicator with handwheel is also available with any of these mechanical remote control features.

R. W. Hooker Re-elected President Chlorine Institute

W. I. Gilliher Elected Vice-President Robt. T. Baldwin Named Secretary for 27th Year

R. W. Hooker, Vice-Pres. in Charge of Sales of the Hooker Electro-chemical Co. was re-elected president of The Chlorine Institute, Inc. at its annual meeting in New York City, January 24th.

Mr. Hooker has been a director of the Chlorine Institute since 1940 and

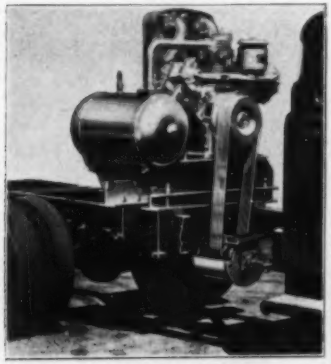
If interested in equipment or literature mentioned above, mail a Reader Service Card with your name, address, and item key number.

prior to his first election to its presidency in 1949, had been a vice-president of the Institute. He has been associated with the chlorine industry for many years as an official of the Hooker Co., one of the country's large producers of liquid chlorine and chlorinated chemical products.

The Chlorine Institute Inc., engages in the technical promotion of the uses of chlorine, especially in the treatment of water, sewage and industrial wastes. The Institute is also active in promoting safety in the packing, transportation, and use of liquid chlorine. Membership of the Institute consists of all firms engaged in the production and sale of chlorine gas or its products. There are 23 active members in the United States and Canada. In addition there are 10 associate members who manufacture equipment for the production or use of chlorine.

W. I. Galliher, Vice-President in Charge of Sales, Columbia Chem. Div., Pittsburgh Plate Glass Co., was elected Vice-President of the Institute.

Robert T. Baldwin, the Institute's secretary since its organization in 1924, was named Secretary for his 27th year of service to the American Chlorine Industry.



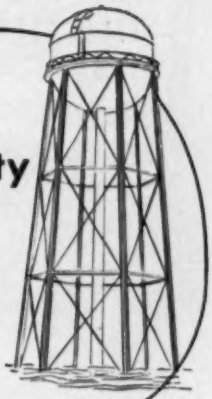
Truck-Mounted-Powered Compressor

305

Jaeger Machine Co., Columbus, Ohio, has developed an air compressor that mounts on any of five popular makes of 1½ and 2-ton rated trucks, adapts to special body designs, and derives power from the truck engine through a simple, rugged power-takeoff.

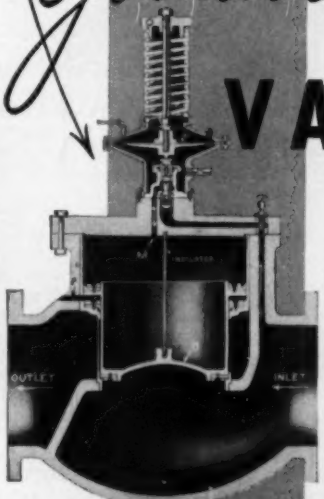
The compressor, Model 125, furnishes 125 cfm. of 100-lb. air. According to Jaeger, it is capable of driving two heavy duty, or three medium duty, pavement breakers at

Your Community
NEEDS DEPENDABLE
WATER LEVEL CONTROL
BY



GA

CUSHIONED
Golden-Anderson
ALTITUDE
VALVES



Golden-Anderson Water Level Control Valves give the safety and protection needed for all elevated tanks and reservoirs. These valves maintain a uniform water level and can additionally be arranged to automatically function pumps, electrical devices or signal lights. The air and water cushioning in all Golden-Anderson valves prevents any shock or hammer and permits valve to operate smoothly at all times. *Write for Bulletin W-4.*

GOLDEN ANDERSON Valve Specialty Company
2075 Koppers Building, Pittsburgh 22, Pa.

THE LEOPOLD GLAZED FIRE CLAY TILE FILTER BOTTOM

Check These Features!

• Low loss of head • Adaptable to any rectangular unit • Practically non-absorbent • Resists acid, alkali solutions • Long life • Equal filtration, distribution • Proved superiority.

Write for details!

F. B. LEOPOLD CO. INC.
2413 W. Carson St., Pittsburgh 4, Pa.

ROTO-TROL

TYPE "A"

Type "A" Roto-Trol operates from the pressure in the pump discharge line, at the pump house. The electric time delay prevents starting or stopping due to surges. It also protects deep well turbines from damage due to back-spin. . . . *Type "A" Multi-Pump Roto-Trol* is designed for two or more pumps discharging into the same discharge pipe. Adjusted time delays compensate for additional pumping friction and surges when second pump starts or stops.

WRITE FOR PERFORMANCE AND ENGINEERING DATA

Water Levels Control Division
HEALY-RUFF COMPANY
783 HAMPDEN AVE., ST. PAUL 4, MINN.

full 90-pressure at the tools. The power-takeoff unit takes the place of a part of the truck's drive shaft, contains no gears and has an extremely simple, solid-shaft-type clutch for directing power to the compressor through v-belts, or to the truck's rear wheels. Two simple levers in the truck cab control all functions.

Williams Honored by Robinson Clay Products

Sales Manager Presented With 35 Year Service Emblem

A. E. Williams, Sales Manager of the Vitrified Products Div. of The Robinson Clay Product Co. of Akron, Ohio, has been honored for 35 years of service. In recognition of his service, he received a diamond studded pin and a company commendation from the firm's president, W. E. Robinson, who is pictured above pinning on Mr. Williams the specially designed 35 year service emblem.

Williams, who hails from New Jersey, began his career with Robinson as a vitrified products salesman. For nine years he was assigned to the Albany, N.Y., office, travelling the New England territory. He opened Robinson's brick and clay yard at Bloomfield, N.J., in 1931, where he remained in charge until 1937. He served as Resident Manager of the Canadian Branch of The Robinson Clay Product Co. of Canada, Ltd., in Toronto from 1937 to 1941 when he was appointed Resident Manager of Robinson's branch office at Indianapolis, Ind., where he served until his appointment as division sales manager a year ago, moving to the firm's main offices in Akron.

Six other Robinson employees received recognition for their service records at the same ceremony in which Williams was honored. Fifteen-year pins were awarded to Gladys Klein, of the Akron office Accounting Department, and John Raddish, a foreman at Robinson's

INSURE YOUR FILTER
AT NO COST
by using our
FILTER SAND and GRAVEL
FOR WATER AND SEWAGE PLANTS

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LIGHTWEIGHT MODEL
One Man Operation
On Every Application

HIGHLY EFFICIENT

IMMEDIATE SHIPMENT

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Free Demonstration and Operating Instructions

JOSEPH G. POLLARD CO., INC.
Pipe Line Equipment
New Hyde Park New York

If interested in equipment or literature mentioned above, mail a Reader Service Card with your name, address, and item key number.

Mogadore, Ohio, plant. Joseph L. Sohner, Akron vitrified products salesman received a 10-year award. Five-year pins went to Edward C. Myers, John L. Austin and Richard G. Hart.

Fisher Scientific Opens Washington Plant

Fisher Scientific Co., Pittsburgh, Pa., has announced the opening of a new plant in Washington, D.C., to serve as a stocking, shipping, and repair center for the Atlantic Seaboard area. The plant is located at 7722 Woodbury Drive.

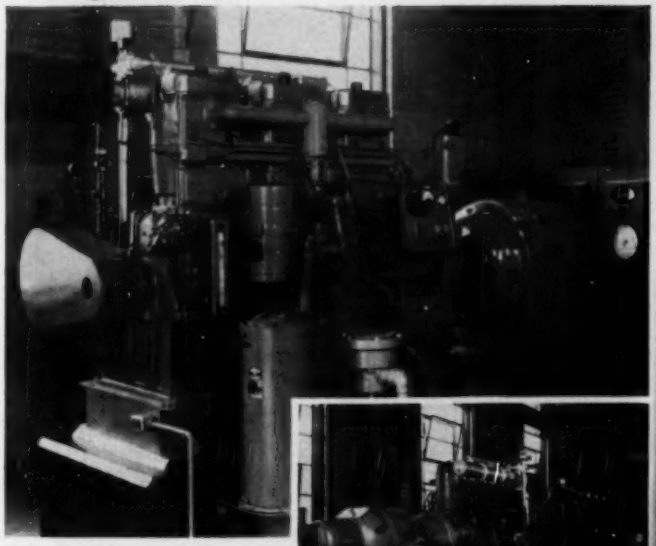
Complete repair, service and demonstration facilities and personnel are on hand to assist scientists of the Washington area in the selection and repair of all Fisher instruments, and those of Beckman Instruments, Inc., and many others. A demonstration laboratory is maintained for the use of laboratory personnel in the area, who wish to examine instruments and equipment under actual use.

Outfall Tide Gate

306

The City of New York, Department of Public Works, has developed, together with Krajewski-Pesant Manufacturing Corp. of New York, a new type of Pontoon Tide gate, which has sufficient buoyancy to permit opening under a 2 inch differential head. The wall casting and frame are made from high test cast iron, while the flaps are constructed entirely from genuine A. M. Byers wrought iron plates and membranes making a multiple number of watertight compartments continuously welded inside and outside from ⅜ inch thick plates. These have

climax SUPREMACY!



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Proof of Climax quality products is that these engines are installed in hundreds of sewage treatment plants. Some of these engines have been in continuous service over 15 years, with a minimum of operating and maintenance expense. Sewage gas engines are available in sizes from 40 to 250 H.P. Gas, gasoline or Butane engines for emergency use are available in sizes up to 600 H.P.

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GK sewer jointing compound

A complete line of jointing materials and accessories for water and sewer pipe. Specific bulletins and Technical Service available to help solve your problems.

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Over a half century of service

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MINERAL PRODUCTS COMPANY
MERTZTOWN, PA. HOUSTON, TEXAS

facing strips finely machined which seal against 1½ square rubber seating strips in dovetailed grooves.

Byron-Jackson Appoints Graffenreid

Byron Jackson Co., Los Angeles, Calif., has announced the appointment of Dean De Graffenreid as District Sales Engineer for the company's Tulsa, Oklahoma, office.

Mr. De Graffenreid joined Byron Jackson in 1947 as test engineer for the pump division. In March 1948 he transferred to the sales department of the pump division and was assigned to the Los Angeles Branch office and in May 1950 was assigned to the division office in Tulsa.

Hooker Increases Chlorine Production

Hooker Electrochemical Co., Niagara Falls, N.Y., have completed their new facilities for the increased production of caustic soda and chlorine at the Tacoma, Wash., plant.

The expansion of production facilities consists primarily of the installation of two circuits of the new Type S-3 electrolytic cells which have far greater capacity than the old cells replaced. In addition, extensive additions have been made for treating and handling brine, for purifying and evaporating caustic soda, and liquefying chlorine. Other facilities completed include a new cell construction and renewal building, additional storage tanks, enlarged water supply system, expanded dock facilities, and other facilities to handle the increased production.

High Heat Resistant Paint

307

Speco, Inc., Cleveland, Ohio, has developed an extra high heat resistant aluminum paint capable of withstanding temperatures up to 1700°F.

Known as HEAT-REM H-170, the new paint utilizes a silicone base and, according to the manufacturer, fuses with surface metal immediately upon application. It is reputed to form a bright, elastic finish resistant to moisture, corrosion, mild acids, alkalis, and industrial fumes. H-170 sets in 4 hours and will dry complete overnight on hot surfaces.

Rockwell Elects Dilworth

Rockwell Manufacturing Co. has elected J. Richardson Dilworth of Princeton, N.J., to the Board of Directors. This announcement was made by W. F. Rockwell, Jr., President of the Company.

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PUMPS PRIMED
FOR INSTANT USE

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WITH V-APCO AUTOMATIC PRIMER
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1450 B. C.

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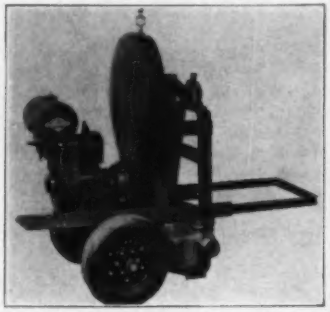
Mr. Dilworth studied law at Yale University and is a member of the Connecticut Bar. Since 1946 he has been associated with the firm of Kuhn, Loeb and Co. in New York City. Mr. Dilworth is also a Director of the Concrete Brick Co. and The Carbon Limestone Co., both of Lowellville, Ohio.



Light-Weight Diaphragm Pumps

308

Marlow Pumps, Ridgewood, N.J., are now producing two light-weight Mud Hog Diaphragm Pumps. Weighing only half as much as other Mud Hog pumps, they can be lifted on and off trucks by two men and easily wheeled around. The light-weight Mud Hogs will lift from levels 25 feet below the pump and handle liquids almost heavy enough to shovel. According to laboratory and field tests by the manufacturer, the 2 inch model will handle up to 2100 gallons per hour and the 3 inch will pump up to 3200 gallons per hour. Both models are mounted on a rigid steel chassis equipped with 12 x 3.00 hollow cushion rubber tires. Cost is said to be almost half that of other Mud Hog Diaphragm pumps.

Pennsalt Scholarship for Employes' Children

Pennsylvania Salt Manufacturing Co., Philadelphia, Pa., informed its employes by letter that their sons and daughters are eligible to compete for a $300-a-year college scholarship provided by George B. Beitzel, Pennsalt president.

One scholarship will be awarded each year, beginning with 1951, to the high school graduate of that year selected as winner of the competition by a board of independent judges. Winners will be selected on the basis of general aptitude and scoring on College Board Entrance Examinations.

The scholarship will be paid to the college of the winning competitor's

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cuts pipe 4" to 8"

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Write for Complete Catalog of Pipe Cutting Tools

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Save man hours

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Since 1875 EDDY For Long Service

After excavation, two unskilled workmen with a ratchet wrench can install these valves in a jiffy . . . and every joint will be *bottle-tight* under pressure. What's more, they can do the work in a flooded trench, or in any kind of weather, for no caulking, no lead-melting is needed. Eddy Mechanical Joint Valves meet AWWA specifications, and are available in sizes 3" to 12" for use on both centrifugally-cast and sand-cast iron water pipes.

EDDY VALVE COMPANY
WATERFORD NEW YORK
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choice in four yearly instalments of $300 each, provided he meets college standards, and will be applied to his tuition and other fees and expenses. Thus, the total scholarship for each winner who satisfactorily completes his college course will be $1,200.

Totally Enclosed Induction Motors

309

Fairbanks, Morse & Co., Chicago, Ill., have recently extended their line of type QZE, totally enclosed, non-ventilated, squirrel cage, induction motors to include continuous duty ratings built in NEMA standard frame 284. At present, 7½ hp., 1800 rpm., and 5 hp., 1200 rpm. motors are in production.

Rotors are Fairbanks-Morse "Copperspun" and ball bearings are of the cartridge type with ample grease space to permit sealing for the life of the bearing. Conduit boxes are the Fairbanks-Morse dual type which makes installation possible where space is limited.

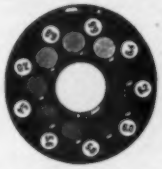
Josam Appoints Director of Public Health Research

Josam Manufacturing Co., Cleveland, Ohio, announced the appointment of Dr. Maryland B. Byrne to the position of Director of Research in Public Health and Sanitation. Mr. L. N. Newman, Executive Vice-President of Josam stated that this move indicates Josam's desire to pioneer a new frontier in the manufacturing field by devoting its time and efforts to broader aspects of public health and sanitation. He also stated that Josam proposes to study the problems of proper sanitation and the handling of industrial wastes and offer the services of Dr. Byrne gratuitously as a consultant and speaker, wherever need is indicated.

Valve & Primer Corp. Moves Offices

Valve and Primer Corp., Chicago, Ill., have announced that they have moved their offices from 127 N. Dearborn Street, Chicago, Ill., to 356 West Huron St., Chicago, Ill.

FOR PRECISE pH Control and WATER TESTS



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Literature and Catalogs

Digester Heater and Heat Exchanger

310

Pacific Flush Tank Co., Chicago, Ill., has just published an attractive, 3 color, 30 page bulletin on the company's **Digester Heater and Heat Exchanger** for controlled digestion. The advantages claimed for this unit and the P.F.T. method of digester heating are: Accelerated digestion by close control of digestion tank temperature, peak heating efficiency by ease of maintenance, elimination of digestion tank shutdowns, positive control and safety of fuel burning, seeding and heating of raw sludge additions, effective utilization of gas produced and automatic changeover to auxiliary fuels, elimination of "layover" scum blanket, high thermal efficiency and overload capacity, and effective utilization of waste heat from engines with complete protection to engine systems.

This booklet presents the history of the method, the experimental work conducted, comparative costs and complete specifications. Photographs of actual installations, diagrammatic drawings and cut-away diagrams provide complete details of the operation and installation of the system.

Expansion Joints

311

Dresser Manufacturing Division of Bradford, Pa., announces the availability of a new four-page leaflet describing the four principal types of **Expansion Joints** which are produced by the company. The four principal types are a Single-End, Double-End, Single-End with limited-movement, and Double-End with limited movement. Sizes range from 3 inch ID to 24 inch OD, but the company states that larger sizes can be furnished upon request.

Telemetering Instruments

312

Bristol Co., Waterbury, Conn., has just published a new folder on **Metameter Telemetering Instruments.** The folder contains information on the use of these instruments for remote recording, indicating and control of variables over distances ranging from a few feet to many miles.

SPARLING MAIN-LINE METERS

for Your

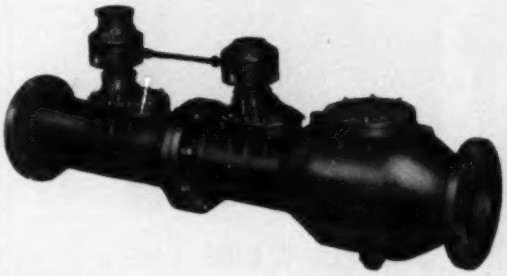
MASTER RECORDS

Every man responsible for water service knows the hazard of *guessing*. It is not enough to know the *rated* capacity of a pump. What is it doing right now?

The instrument at right tells all—direct totalization — present rate of flow — a complete picture of each 24 hours' or 7 days' deliveries. It can be installed close to, or miles away from, the Sparling Direct Action Meter that controls it.

and Practically NO Pressure Drop!

Sparling Meters are noted for their conservation of line pressure. Even the Compound Meters—shown below, with flow ranges as high as 1 to 125—show less head loss than ordinary meters. That is part of Sparling economy.



Bulletin 311 comes upon request

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LABORATORY MIXER

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A Filter Medium For All Purposes

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Engineers and Sales Agents

A number of typical installations of Metameter Telemeters in use on water distribution systems are illustrated and described. Among the applications given are remote readings of water level in reservoirs, lakes, rivers, and storage tanks; flow through flumes and over weirs; pressure in high pressure and distribution mains; and remote automatic pump control.

Corrosion Inhibitor

313

Allis-Chalmers Manufacturing Co., Milwaukee, Wis., has released a new leaflet describing the manner in which **Allis-Chalmers No. 160 Series Corrosion Inhibitor** acts by neutralization and by surface absorption to control the corrosion of steam and condensate lines.

The leaflet states that the corrosion inhibitor is a mixture of the most effective organic amines selected according to volatility characteristics required by each steam condensate system. It is a colorless liquid with a slight odor and contains no ammonia.

Use of the inhibitor is recommended where economic considerations do not justify expenditures for deionizers or sodium-hydrogen zeolite softeners.

Flow Rate Testing

314

Fischer & Porter Co., Hatboro, Penn., has announced the release of a **Technical Report on Fluid Flow Rate Testing.** This Technical Report was originally prepared for the company staff engineers and contains comprehensive data on the newest technical developments on fluid flow rate testing.

A complete discussion of engineering principles as well as detailed flow curves and charts is included. In addition, this bulletin describes the newest calibration techniques and illustrates modern precision-accuracy calibration panels.

Softener and Coagulator

315

Worthington Pump and Machinery Corp., Harrison, N.J., has announced a new bulletin describing the **Type CM Precipitating Softener and Coagulator** in which energy for floc preparation is mechanical.

This supplements Bulletin W-212-B5, which describes the Worthington hydraulically motivated system and the elementary chemical theory of softening. The new bulletin de-

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scribes the flow circuit, diagrams the flow, and answers nine questions in a system appraisal.

Prestressed Concrete Steel-Cylinder Pipe

316

Price Brothers Co., Dayton, Ohio, has just published a booklet on **Prestressed Concrete Steel-Cylinder Pipe.**

The booklet shows by means of photographs and text the exact steps and processes in the manufacture of the pipe. On page three is an explanation of how the steel cylinder and concrete core are prestressed to form an elastic structure, and how the pipe handles high pressures with a minimum of stress. Page four shows a cut-away diagram of how the flexible watertight joint is made with the pipe.

Pipe and Drainage Installation

317

Armco Drainage & Metal Products, Inc., Middletown, Ohio, has published an illustrated 46-page **Installation Manual of Armco Drainage Products.**

Designed to assist in the proper methods of installing Armco drainage structures, culverts, sewers or conduits, the manual first discusses the handling of metal drainage products, location, proper excavation and preparation of base in various types of foundation soils and rock. This is followed by detailed instructions for the assembly of corrugated metal pipe, coated or paved pipe, Pipe-Arches, Hel-Cor pipe, and Multi-Plate pipe and arches. Next are recommendations for proper backfilling pipe, Pipe-Arches, and arches for various loading conditions. Installation of underdrains to insure proper functioning is also discussed.

Detailed sketches are used throughout the manual to illustrate important installation recommendations.

Worm Gear Drives

318

Link-Belt Co., Chicago, Ill., has just published an 80-page Book on **Link-Belt Worm Gear Drives.** The Drives illustrated, described and tabulated in the new book are of three basic types, each available in 10 different sizes, for fractional or large horsepower, and in speed ratios of 3⅝ to 1 up to 8000 to 1.

Features enumerated for these enclosed right-angle drives are—Com-

A Royer Sludge Disintegrator at work in Reno, Nevada

SEWAGE SLUDGE IS VALUABLE ...SELL IT!

With a Royer Sludge Disintegrator you can take your sewage sludge cake right from the sludge beds and process it into a readily saleable fertilizer. Just shovel it into the hopper of the Royer, add commercial fertilizer as desired, and the Royer does the rest. Sludge cake with moisture content as high as 56% is completely shredded, pulverized and aerated . . . and at a labor cost less than that of burning or burying it. Sticks, stones and trash are removed and the finished product can be discharged into truck, pile or bags.

Florists and nurserymen, golf clubs and parks are ready customers for this valuable, nitrogen-rich plant food. Use a Royer Sludge Disintegrator . . . turn an expense item into a source of steady income.

A free copy of our Sewage Sludge Datalog giving all the facts will be sent to you upon request.

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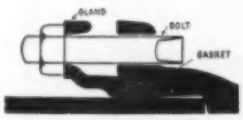
MAGIC WAND!

RATCHET WRENCH IS ONLY TOOL NEEDED TO LAY McWANE BOLTITE MECHANICAL JOINT PIPE

There's magic in a ratchet wrench when you lay McWane "Boltite" Mechanical Joint Cast Iron Pipe. A ratchet wrench is the only tool needed for one man to make "Boltite" joints. He simply slips the follower-ring and the gasket over the spigot end, then sockets the pipe, inserts the gasket into the stuffing box and bolts up the follower-ring for a bottle-tight, flexible joint. McWane Boltite pipe is furnished in sizes 2-inch through 12-inch, in 18-foot lengths. The follower-ring, gasket and bolts are interchangeable with any make of standard mechanical joint pipe. For further details, write McWANE CAST IRON PIPE COMPANY, BIRMINGHAM 2, ALABAMA.



Boltite pipe is used for water, gas, steam, oil, chemicals and other liquids. Gaskets are rubber compound, asbestos, duck tipped, and other materials for special services.

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a clear liquid penetrating (1"+) sealer for concrete and masonry preventing water absorption and reducing the action of acids. Holds 12' hydrostatic head. Use our Hayproc Rubberized Enamel for color on walls and floors—not affected by concentrated acids, alcohol, oil, or traffic abrasion.

30 OTHER PRODUCTS

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2200 volt, 3 phase, 60 cycle Weatherproof construction including Thermoguards.

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pact design; anti-friction bearings; automatic splash lubrication; high ratios in small space; operation at high input speeds; quiet performance; and their availability for vertical or horizontal driving.

Pages 10 through 15 contain typical drive problems with their solutions and show the ease with which the proper drive may be selected for a specific duty.

Laboratory Safety

319

Fisher Scientific Co., Pittsburgh, Pa., has announced the publication of a newly revised edition of the 40-page booklet entitled **Manual of Laboratory Safety.**

According to the company, the original material has been brought up-to-date by the inclusion of recently developed data, techniques and equipment; the new manual will prove to be useful in the implementation of complete laboratory safety programs.

Right Angle Geared Pump Drives

320

Peerless Pump Division, Food Machinery and Chemical Corp., Los Angeles, Calif., has just published a comprehensive new bulletin on the **Peerless Gearturbo Pump Head.**

The new bulletin describes the construction features of the Peerless right angle gear head and includes complete sectional drawings and dimensions, details of the flexible shafts for connecting driver to the pump head, horsepower ratings of the various size heads and data on combination heads, where electric and right angle gear Peerless pump heads are combined in one unit for stationary engine drive and direct-connected electric power. Suggested methods of installation are shown in station arrangement sketches.

Motor-Generator Booklet

321

General Electric Co., Schenectady, N.Y., has announced a new 8-page, two-color booklet on synchronous motor-generator sets.

Designated as **GEA-5506,** the booklet covers motor-generator sets from 30 to 8,000 kw. as a source of DC power for many applications.

Well illustrated, the booklet shows four typical installations and describes the construction features of the synchronous motors and DC generators. Motor ratings include 60, 50

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and 25 cycles, 0.8 pf, 220 to 13,200 volts. Generators, both shunt and compound wound, are rated 125, 250 and 600 volts capacity.

Light-Weight Pipe

322

Naylor Pipe Co., Chicago, Ill., has just published a new bulletin on **Naylor Light-Weight Pipe** which shows typical applications of the Lockseam Spiralweld Pipe in sewage disposal, construction, dredging and other fields.

The bulletin includes data on fittings, flanges, connections, and pipe specifications from 4 to 30 inches in diameter.

Right Angle Motor Reducer

323

Falk Corp., Milwaukee, Wis., has just released a new bulletin illustrating and describing their **All-Steel Right Angle Motoreducer** which combines the advantages of the company's standard Motoreducer with the adaptable right angle head. The bulletin discusses by means of text, photographs and drawings, typical applications, methods of selection and AGMA load classifications. Selection tables, special tables, dimensions and inquiry guides are also included. The back of the bulletin contains information on Falk Steelflex Couplings and other Falk products. A complete list of all district offices and representatives is shown on the back cover.

Metal Inspection

324

Dy-Chek Co., Hawthorne, Calif., has issued a new illustrated **Dy-Chek Bulletin 500** which fully describes "Dy-Chek," the Dye Penetrant Method of metal inspection, and shows how this chemical process simplifies non-destructive testing. Dip, brush and spray methods are explained, and varied applications in plants and in the field are discussed.

WANTED:

Position as manager Water or Water Sanitation Utility. Fifteen years Waterworks management experience. Registered Professional Engineer. Six years present position as Water & Sanitation Supt. midwestern City of 20,000. Desire to make change due to political situation. Will consider foreign position.

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These two photos show a large, circular, gravity dam belonging to a large Eastern power company, and is just one of many that we have repaired with "GUNITE" for this organization.

The Upper View shows the advanced state of disintegration existing before our Contract Department started work on the dam; lower view shows the completed job.

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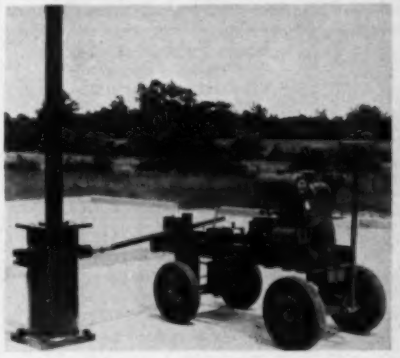

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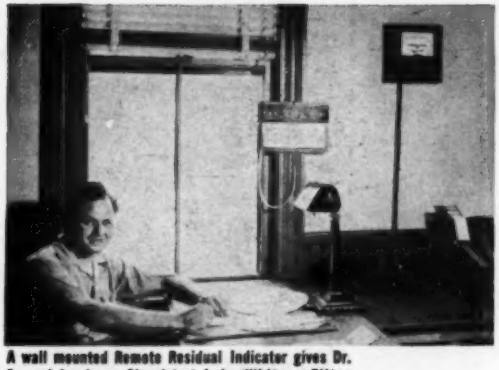

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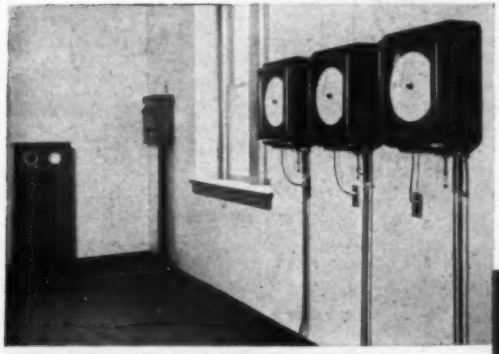
Wallace & Tiernan Residual Chlorine Recorder at Lake Whitney Filter Plant.



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